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David James Kemp 1945–2013

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David Kemp's seminal contributions to molecular parasitology of malaria and scabies have placed Australian science at the forefront of research on these important human pathogens. Immunoscreening of expression clones led to the identification of several vaccine candidates against malaria. His contributions to scabies research are pivotal to our understanding of bacteria–parasite–human interactions. Other notable achievements are: the discovery of one of the earliest known multi-gene families; the first cloning of linked variable-region genes in the immunoglobulin heavy-chain locus; the invention of highly cited molecular biology methods, namely Northern blotting and inverted-PCR; and contributions to 'molecular public health' by his work on various bacterial infections relevant to the health of Indigenous Australians. Kemp's manifest enthusiasm for science was highly infectious. He mentored many high-achieving scientists. In addition to his exemplary career as a scientist, he was a musician at heart and a passionate rock fossicker.

Early Years

David James Kemp was born in Adelaide on 23 July 1945, the second son of Albert and Marjorie Kemp and younger brother of Robert Kemp.

Upon hearing of Dave's passing, his great mentor and friend Sir Gustav Nossal described him as a 'singularly inventive man'. This inventive nature came from his father Albert, who worked for the automobile manufacturer General Motors Holden as a toolmaker in the engine department. When the Second World War started, Albert's skills were deemed of national importance and he was denied entry into the Army; instead, he worked on a motor for an Australian-made Spitfire aircraft. The Australian Spitfire never saw full production but Albert's skills gave him considerable gravitas in the industry.

An early source of pride for Dave was the support he gave his father in his work as a manager at General Motors Holden. Like many of his generation, Albert was significantly affected by the Great Depression of the 1930s, leaving school early to take on jobs to support family. But Albert's skill with his hands saw him promoted to line manager, where the work included the writing of reports. This he found impossible: even though he could read, he had great difficulty in writing. Albert would dictate his reports to young Dave, who would write them out for him.

In the process, Dave helped Albert learn to write, to a point where Albert could complete his work himself. When asked about this, Dave pointed out that it was common for Albert's generation to have problems with reading and writing. To

him, it seemed perfectly reasonable that he help his father, even though he was only a boy himself.

Dave's childhood was spent outdoors. He often talked about how much change had occurred during his life by telling stories of the neighbourhood he grew up in. As one of the new industrialized areas of Adelaide, Woodville where the Kemps lived was the home of the Kelvinator refrigerator factory and General Motors Holden. The street that Dave's family lived on was still undeveloped and his home was surrounded by paddocks.

A very early source of inspiration for Dave was watching the transit of Sputnik, the first satellite to orbit the Earth. Dave often recalled standing outside in the middle of the night to watch as Sputnik passed overhead. Similarly, the moon landing in 1969 fascinated his young mind and gave him an immense sense of the possibilities that life could hold.

Dave's love for geology started very early. When Dave found that a friend of his age who lived down the road had joined a geology club with his older brother and that they were going on a field trip to the Flinders Ranges, Dave joined as well. He later marvelled at how those in charge would allow the young boys to enter abandoned mine shafts, something that would never be allowed today. The rule was: you could go down the mine as long as there were two of you, one to go down the mine and one to keep watch at the top in case of emergency. In later years, Dave and his wife Kath often spent weeks in outback Australia while Dave searched for 'that rock'. Many times he would passionately talk about his collection of rocks and sometimes he would narrate stories relating to some of these. For instance, he would talk about his field trips during his younger days to Cambrian-era fossil fields.

When asked why he did not take up geology, Dave, no doubt partly tongue in cheek, gave two reasons. First, he said, there was far too much mathematics involved and he did not like mathematics. Second, studying geology would have taken him away from the city and the jazz clubs. Dave loved playing the double bass and anything that would take him away from being able to play in jazz bands was not an option.

From a very early age, Dave showed high academic potential. He attended Woodville Primary School and Woodville High School, where he was a school prefect. At the start of his matriculation year, he recorded the fastest reading speed in the history of the tests, a score well above the state average. Interestingly, though, one of us (MG) recalls him saying that he was not a reader of fiction. Dave completed the matriculation examination in 1962 with the highest score in the State, for which he was awarded a prize of £200, an incredible amount for a young man in those days. Instead of using the money to support his academic career, Dave bought his first double bass and his jazz career had begun.

After completing his secondary education, Dave took up a grant from the South Australian Department of Education to attend Teacher's College. He found, however, that he did not enjoy teaching in a classroom situation and instead practised music with great zeal, neglecting his teaching studies. Dave was recognized as the second-best double bass player in Adelaide and was often asked to play in in-house bands including the Channel 7 television station's orchestra for their annual telethon raising money for charity. Dave also played for the three Gibb brothers who went on to international success as the BeeGees.

Dave often told the story of his first gig, during which he was approached by his fellow musicians and asked whether he was in the musicians' union. When Dave stated that he was not, he was told that while he could play on that night, he would not be allowed to play again unless he joined. Dave joined the musicians' union the next day and, because he lived close to the union's headquarters, was given a set of keys to open the bar. Many a night, he said, was spent at the musicians' union, drinking and playing into the early hours of the morning.

Dave's double bass is also quite famous. Originally owned by the family of the Australian optical company, Laubman and Pank, the double bass has been loaned to many famous Australian bands including The Seekers and, when Dave was in Darwin, Paul Kelly's band. Dave used to say that he knew that he could show up at any research institute and within an hour have a band together. Indeed, putting together a band was one of his early achievements soon after joining, in turn, the Walter and Eliza Hall Institute of Medical Research, the Menzies School of Health Research (Menzies) and the Queensland Institute of Medical Research (QIMR) (Fig. 1).

Figure 1. Dave Kemp and his double bass: serious at work.

Jon Hartas, a colleague and guitarist in his band, recollects that 'indigenous and non-indigenous band members came together in the pursuit of shared cultural experiences. One of his favourite gigs was the Air Med 50th Anniversary Ball held on the lawns of the Diamond Beach Casino in Darwin, 1996. … A lot of effort went in. Dave must have been feeling the pressure, as after the very successful night, he expressed much happiness along with a little surprise that his eclectic group had performed so well.' Sadly, Dave developed significant issues with arthritis and had to stop playing in his last few years.

In 1966, Dave was playing double bass with a jazz band in the famous Adelaide venue, the Haughton pavilion, and living in shared accommodation with the band. On the night of his twenty-first birthday, Dave was given the greatest gift he ever received, an introduction to a young and very attractive nursing student named Katherine Mary Wakefield. From that night on, Dave and Kath were together constantly, and they soon married. Kath, daughter of Philip Basil Wakefield and Ellen Alice Wakefield, did her training in Adelaide and later specialized in midwifery and intensive care. After she and Dave moved to Melbourne, she worked at the Royal Melbourne Hospital where she was promoted to Assistant Director of Nursing during which time she completed a BAppSc degree in nursing administration. When they moved to Darwin, Kath began work with Indigenous Australians with whom she had a deep affinity.

Research Scientist

Dave's entry into a research career could be described as a reluctant one. He was unsure whether he should remain a musician or enter academia. He probably wanted to test waters when he joined the University of Adelaide.

From his early years Dave exhibited a flair for innovation. As his family recalls: 'Dave was always creative, which he put down to being allowed to go to his father's shed and to play with all the machinery and wood that was lying around.' A story that his cousin recounted was about a cubby house that Dave had built. Rather than building in a tree, as most children do, Dave built underground, digging out a hillside and reinforcing it with cross beams; remarkable ingenuity for a young boy. This aptitude certainly continued throughout his career. As Sir Gus Nossal puts it, he was

> an innovative, resourceful and extremely enthusiastic scientist …. Kemp's manifest enthusiasm for science was highly infectious. It led to a very lively spirit in his laboratory. Kemp was very inventive, and if he needed something for his research that was difficult to access, he just made it. For example, in the early days of the polymerase chain reaction (PCR), when equipment was still quite expensive, together with the WEHI [Walter and Eliza Hall Institute] workshop he built his own PCR machine, which worked very well. He was an inveterate improver of techniques, to the benefit not only of his own laboratory but of many scientists elsewhere in the Institute.

Graham Mitchell recalls: 'Dave is associated with numerous discoveries and inventions that include new technologies in molecular biology, malaria genetics including gene expression and chromosome analysis and diagnostic methods'.

Dave was a great mentor to many in the field of malaria and scabies research. Indeed, he was pivotal to the development of these fields in Australia. Dave's four decades of contributions to science is like a gorgeous necklace with many different segments or pendants, each studded with one or more beautiful gems. To list highlights of his work in a chronological order

we have chosen to refer to each segment of his working life either by the topic of his research or by the institute at which he did the work. In total he published 225 peer-reviewed research articles, reviews and book chapters. As of April 2014, his work has been cited more than 13,300 times, with thirty of his publications cited at least one hundred times and a Hirsh index of 57—an extraordinary achievement in this area.

The 'Feather Keratin' Period (1969–75)

After completing a First Class Honours degree at the University of Adelaide in 1969, he enrolled in a PhD programme (1969–73) with George Rogers. The project was to study organization of avian feather keratin genes, characterization of their transcripts and *in vitro* translation. He then continued with Rogers for two years as a post-doctoral fellow. This period produced nine papers [1–9], the highlight (gem) being that the keratin genes constituted one of the earliest-known multi-gene families, a discovery that resulted in a single-authored feature article in *Nature* [3]. Dave was awarded the William Culross Prize for the best thesis at the University of Adelaide in the year 1973. This is what Alan Cowman (Dave's first student), Lynn Corcoran and Suzanne Cory wrote about this work: 'He discovered his great love of scientific research whilst doing his PhD with George Rogers at the University of Adelaide. Indeed, he published a manuscript in Nature on the organisation of feather keratin genes for which he was the only author, an amazing feat for a PhD student and an indication of his outstanding scientific talent.' (http://www.wehi.edu.au/about_us/history/a_tribute_to_dave_kemp/).

The 'Stanford' Period (1976–7)

In 1975, just before taking up the Eleanor Roosevelt Fellowship that he had been awarded to study Drosophila molecular biology with David Hogness at Stanford University, Dave spent a brief period in Canberra with Jim Peacock at the CSIRO Division of Plant Industry to familiarize himself with the trade of molecular biology, and worked on mRNA of insect storage protein [10]. At Stanford, Dave did not achieve major publications in drosophila biology but he gained tremendous expertise in molecular biology that served him well in subsequent years. During this period, in collaboration with Alwine and Stark, he invented the 'Northern Blot', a universal method for detection of specific RNAs on gel blots. This gem was published in the *Proceedings of the National Academy of Sciences* (USA) and *Methods in Enzymology* [11, 12], and the former is his highest cited article, with 1,889 citations.

The 'Immunoglobulin Genes' Period (1978–80)

Fortunately for Australian science, Dave returned to Australia—we believe we owe this to his wife Kath Kemp—where he joined Jerry Adams and Suzanne Cory at the Walter and Eliza Hall Institute for Medical Research (WEHI) in Melbourne. Of the ten publications from this segment of his career [13–22], five were in the *Proceedings of the National Academy of Sciences* and two were in *Nature*. Dave pioneered the cloning of genomic DNA and cDNA from mammalian cells, leading to a major contribution in this period, the first cloning of linked variable-region genes in the immunoglobulin heavy-chain locus. These multiple genes are a major basis of V_H gene diversity. For his contribution to this work Dave was awarded the Boehringer Medal by the Australian Biochemical Society in 1981.

The 'Malaria at WEHI' Period (1981–92)

In the early 1980s Dave was encouraged to apply his recombinant DNA expertise to the immunoparasitology programme at WEHI at the behest of Sir Gus Nossal and Graham Mitchell. This triggered a move to parasitology. Dave's main work was geared to the creation of a malaria vaccine, to be funded by a new, major grant from the MacArthur Foundation. He adapted techniques for the expression cloning of key malarial antigens, based on improvements of the techniques of Young and Davis. Central to the endeavour also was Robin Anders who used sera from malaria sufferers in endemic areas to reveal the key antigens being expressed through immunobinding. As a result of this work, several vaccine candidates for the blood stage of the parasite (the merozoite) were designed. Some went into clinical trial, one combination giving mildly encouraging results. This strategy became a general method for the search and characterization of vaccine antigens in many pathogens.

Sir Gus recalls: 'Genes for many of the antigens were molecularly cloned and sequenced, revealing many fascinating aspects of their structure. A common feature in many cases was the occurrence of tandem repeats of certain runs of amino acids. This became so deeply impregnated into WEHI folklore that it was not difficult to call the talented amateur jazz group that Kemp founded: The Tandem Repeats'!

In 1984, Dave initiated innovative studies separating malaria chromosomes using the new technology called pulsed field gel electrophoresis. For this, Dave designed and helped construct massive electrophoresis tanks with pumps and reservoirs the size of bathtubs. The data obtained provided the basis for understanding the structure and arrangement of the genome and ultimately the sequencing of the malaria genome. This led to rapid development of the field and WEHI quickly became internationally renowned for its innovative research in malaria (Alan Cowman, Lynn Corcoran and Suzanne Cory; http://www.theage.com.au/comment/obituaries/musicloving-scientist-who-was-lauded-for-parasitology-research-20131208-2yzj2.html).

During his twelve years at WEHI, Dave published most prolifically, accumulating in excess of 120 publications of which two-thirds were on Plasmodium [23–102]. Of these, two were in *Cell*, five were in *Nature* and eleven were in *Proceedings of the National Academy of Sciences*. There are many gems in this segment. In addition to the abovementioned antibody screening of expression libraries and malaria macro-genetics, Dave discovered a simple method called 'inverted PCR' to characterize sequences external to known regions of DNA. His publication [103] on 'Inverted PCR' is his second most cited paper (660 citations). The 'inverted PCR' was originally conceptualized by Dave while he was taking a shower, and very quickly the concept was proven (http://www.wehi.edu.au/about_us/history/a_tribute_to_dave_kemp/). Then he developed a colorimetric method for detection of amplified DNA using ELISA technology [104]. The Wellcome Prize for Diagnostics was awarded to him in 1992 for this work.

In 1990 Dave was promoted to Senior Principal Research Fellow. His work during this period provided immense information on the biology of Plasmodium. Its chromosomes, in particular chromosome 9, were characterized by cloning into yeast and pulsed field gel electrophoresis leading to a better understanding of genetics and antigenic variation in this parasite [36, 43, 44, 71, 82, 89, 93, 105, 106]. This aspect of his study was to continue at the Menzies School of Health Research in Darwin ('Menzies').

'Dave's sparkling personality impressed visitors and donors to the WEHI. Partly as a result of this, but more because of the excellence of the work, great grant support from the MacArthur Foundation ensued', commented Sir Gus Nossal.

Following Graham Mitchell's departure from WEHI, David Kemp was appointed head of the unit and held that position for several years before leaving to become Deputy Director of the Menzies in Darwin. As a laboratory head, Dave was highly supportive of younger colleagues, quickly recognising the rising stars and ensuring that a good team spirit existed within his laboratory. When Dave recognized someone's particular talent, he made sure they knew it was recognized, and he generously related his views to the future mentors of his students and postdocs. The camaraderie was enhanced by a marvellous sense of humour, and he was in top form when the research was going well and all in the laboratory were in high spirits. Dave left WEHI with goodwill from all, having been a very popular figure.

The 'Infectious Diseases at Menzies' Period (1992–2000)

As mentioned above, Dave and Kath had made several trips to outback Australia, almost all of it involving rock collecting. During these trips they wished they could contribute to research on the health of Indigenous people. Furthermore, neither liked living in a metropolis. Dave and Kath were delighted when Dave received a job offer from Menzies. For them this was a great opportunity to achieve what they had contemplated. With no further consideration, Kath pulled out suitcases and started packing. At the following Lorne Conference many delegates asked one of us (KS), with obvious awe, how John Mathews, the Founding Director of Menzies, had managed such a coup. This is how John remembers it:

> Ora Bernard from WEHI, when visiting Menzies in Darwin in 1990, first told me about Dave

> Kemp and his wonderful talent for molecular biology. About the same time, I read 'Life Amongst the Scientists', by Max Charlesworth and colleagues, a book reporting an anthropological study of the scientific culture at WEHI. Dave and other colourful scientists at WEHI could be identified by those who knew them, despite the use of pseudonyms in the book. Because of his lifelong passion for geology and fossicking, Dave was drawn to the Australian outback, and so he visited us at Menzies in Darwin in 1991, and gave a great seminar about his malaria work. Later I visited Dave at WEHI in Melbourne, to sound him out about the possibility of coming to Darwin to fill the new position of deputy director at Menzies. He responded enthusiastically, and we began working on the details to make the appointment.

In 1992 Dave was appointed to the newly created Deputy Directorship of the Menzies and Head of the Molecular Parasitology Unit. He was also appointed as a Howard Hughes Fellow from 1993 to 1997. Meanwhile Kath became a valued member of the Menzies ear-health team.

Dave was quick to realize that the Northern Territory was a fertile ground in which to apply his molecular expertise to many infectious diseases. John Mathews recalls: 'The recruitment of David Kemp was a turning-point for Menzies. His expertise, his reputation, and his enthusiasm helped to generate new projects and new funding opportunities, to attract or stimulate wonderful collaborations with other talented scientists, and to build bridges between the laboratory and the pressing public health problems in tropical and Aboriginal health.' Soon he made contributions to further the understanding of organisms responsible for melioidosis, donovanosis, otitis media, scabies, chlamydial and streptococcal infections.

Dave's laboratory at Menzies was next door to mine (KS). The two laboratories used to have joint meetings. Sometimes our younger colleagues would be disheartened at poor cloning efficiencies, whereupon Dave would put them at ease by saying 'The difference between one right clone and no clone is infinity'. During his early days at Menzies, for lunch breaks Dave and I (KS) used to make our way, sometimes together, to our offices in another building. On one such occasion soon after his taking up his position, Dave asked with true concern: 'Sri, are you in any way being threatened by my coming here? Maybe you feel that there is no room for two of similar kind at Menzies'. To this I answered, 'No, in fact I am thrilled. All of a sudden the nucleus of molecular biologists here has doubled, and I just have to walk out of my office to talk in molecular biology lingo and make myself perfectly understood by at least one other person'. 'Thanks, the same applies to me too' was his response.

Having become a world-renowned malariologist, Dave first established a malaria laboratory at Menzies. During his eight years in Darwin he published only seven papers on malaria for which the work was carried out entirely at Menzies [107–113], but the task was not easy. In Dave's own words, it was 'a daunting decade-long challenge in an organism with essentially no genetics'. Importantly, however, together with Don Gardiner, Katharine Trenholme, Peter Burke and others, Dave identified the cytoadherence-linked asexual gene (CLAG) by positional genetics. CLAG is essential for parasitised red blood cells to cytoadhere to the human cell surface receptor CD36 [109, 110, 112, 113]. This fascinating work was to continue later at QIMR.

This period was also marked by Wellcome Trust funding to a consortium of five laboratories (WEHI; the Institute of Molecular Medicine, Oxford; the Institute of Medical Research, Mill Hill; the Sloan-Kettering Institute, New York; and Menzies) to obtain a first high-resolution map, paving the way for the malaria genome sequencing project [108, 111, 114]. Dave was the head of this consortium.

Dave was open to collaborating with other researchers at Menzies and contributing molecular approaches to better understanding of the foundations of many clinical infectious diseases. The first of these was work with Bart Currie on clonal spread to non-endemic regions of *Burkholderia pseudomallei*, the aetiological agent of melioidosis [115]. He then went on to contribute to the identification of the likely source of a highly virulent clone of *B. pseudomallei* recovered from a remote Indigenous community [116].

Dave used to enjoy long walks in Darwin. Al Yonovitz of the Ear Health Unit at Menzies and Dave walked for five years along the Nightcliff shore in Darwin, without fail. The goal was to burn calories and to provide the evening 'seminar' on molecular biology and audiology. On

the first, the goal was not always realized on account of the caloric intake from a satisfying beer taken at the pub along the way. Dave and Al were so consistent that walking continued even during the wet season, with the 'seminar' moved to the in-door Casuarina shopping area. Walking briskly up and down the aisles of the Coles supermarket while vigorously discussing CLAG 9 and antibiotic trials on the Tiwi Islands drew enough curiosity that these strange walkers were written about in the local press. 'Dave shared an 'out of lab' perspective that saw life with humour, honour, vision and kindness; I miss Dave as both a scientist and humanist', Al commented.

Their discussions during these walks triggered Dave's interest in deafness and its profound effect on education among Indigenous children. Otitis media is the main cause of this debilitating outcome. By this time John Mathews, Amanda Leach and others had established that non-encapsulated *Haemophilus influenzae*, *Moraxella catarrahlis* and *Streptococcus pneumoniae* colonized ears of Indigenous children in the first few months of their lives (Leach *et al*. 1994). In order to understand better the role of non-encapsulated *H. influenzae* (NcHi) in ear diseases, a highly discriminative molecular typing method was needed. In collaboration with John Mathews, Amanda Leach and others, Dave demonstrated that horizontal gene transfers are common in these bacteria in the natural environment [117–120]. Furthermore, genetic exchanges seem to happen even between NcHi and *H. influenza* type B, an agent responsible for life-threatening diseases including meningitis, especially among children [120].

Donovanosis is a genital ulcerative disease caused by the bacterium *Calymmatobacterium ganulomatis*. It is difficult to diagnose and culturing the bacterium was extremely difficult. In collaboration with Frank Bowden, Sue Hutton and others, Dave contributed to its successful culturing [121]. Diagnosis of donovanosis was primarily based on clinical presentation and histology. Morphologically, the bacterium is indistinguishable from *Klebsiella spp*; indeed, subsequent molecular phylogeny studies by Dave and others resulted in reallocation of this species to the genus *Klebsiella* [122]. Nonetheless, consistent differences in the *phoE* gene of *K. granulomatis* and other *Klebsiella* species were found [123] and based on this finding, a colorimetric diagnostic method was later developed [124].

Dave and I (KS) have developed a long-PCR-based typing method called 'vir typing' for *Streptococcus pyogenes* [125]. This simple and rapid typing method has subsequently helped identifying different strains within M non-typeable isolates of *S. pyogenes*, a necessity in the understanding of streptococcal epidemiology in the Northern Territory and elsewhere where most isolates were non-typeable.

Looking for greater challenges and the satisfaction of carrying out work that could benefit the health of the Indigenous people, Dave settled on the ectoparasite, the scabies mite. In a way this offered him a transition to do something totally different from his malaria research while continuing in the realm of parasitology. In collaboration with Bart Currie and Shelley Walton, one of Dave's many PhD students, this work continued beyond his Menzies years. Scabies infection in itself is not a major health issue but the ailments that can follow, such as rheumatic heart disease and renal disease, certainly are. Australia's Aboriginal and Torres Strait Islander populations suffer the highest reported rates of these diseases. Worldwide, over 500,000 individuals, mostly young people, die from these post-streptococcal diseases every year. By the mid-1990s, Dave was convinced that control of scabies was paramount in the prevention of streptococcal and other skin infections. While scabies control programmes were available, very little was known of this ectoparasite. Also, there was a belief that human infestations may have a zoonotic origin from infested dogs. Dave recognized the enormous public health implications if this were indeed true, and answering this specific question formed the basis of Shelley Walton's PhD under Dave's supervision. This was the beginning of a major new direction in Dave's research that continued for the rest of his career. In a most innovative series of experiments, DNA fingerprinting of *Sarcoptes scabiei* recovered from humans and dogs from Australia and the Americas helped prove conclusively that the dog-derived mites are distinct from human-derived mites [126]. This discovery led to the reassessment of allocating resources for human scabies to control zoonotic infections from dogs.

Dave's innovative contributions to the understanding of scabies and donovanosis were especially remarkable and attracted international acclaim. Subsequent identification and characterization of a multigene family of inactive serine proteases was the start of current understanding of the molecular biology of the scabies ectoparasite.

At about this time, Dave decided to move to the Queensland Institute of Medical Research (now the QIMR Berghofer Medical Research Institute), after spending time as Acting Director of Menzies when John Mathews moved to Canberra. His collaborative work on skin, respiratory and other pathogens led to the coining of the term 'molecular public health' to describe his innovative leadership. At their farewell from Darwin, Dave and Kath were described as the 'heart and soul of Menzies'.

Dave liked spicy food, so he used to visit me (KS) and my wife Geetha during weekends to learn Indian cooking from Geetha. He was very proud of his achievements in that department. Once, he cooked one of his favourite dishes and asked my mother to mark it. Alas, she gave him only 7/10, remarking that the ginger wasn't sufficiently finely cut. Dave was grumpy for the next few days! In 2012 Geetha and I visited him for a couple of days at Tallangatta, Victoria. To our surprise his collection of spices overflowed his pantry into his study where he had two chests filled with all sorts of spices. Such was his passion in whatever he undertook—be it music, be it rock collecting, be it science, be it cooking.

The 'Scabies Research at QIMR' Period (2000–13)

After moving to QIMR in 2000, Dave reorganized his priorities. (The following year I (KS) also moved to QIMR.) After an initial burst of further research on malaria [127–133], Dave's interest in this field slowly waned, whereas his efforts to achieve a better understanding of the biology of *S. scabiei* continued. He maintained his links with Menzies. His group at QIMR Berghofer, now headed by Katja Fischer, has contributed enormously to our current understanding of this parasite [134–147]. Dave and his Menzies colleagues Deb Holt (who worked with Dave at WEHI, Menzies and QIMR) and Shelley Walton and PhD student Pearly Harumal had constructed the first c-DNA library of the scabies mite at Menzies [148]. An enormously expanded cDNA library was constructed in Dave's early years at QIMR with help from Katja Fischer and Deb Holt. This library was the basis for the identification of homologues of house dust mite allergens [138] and of a multigene family of inactive serine proteases. These inactive paralogues were present both inside the mite's gut and outside in skin burrows [139]. Dave was bent upon finding the implications of this. In collaboration with Katja Fischer, Anna Blom and Rob Pike, he contributed to the study of structural features of these inactive proteases [142], and later showed that many of them inhibit all three complement pathways early in their respective cascades [141]. This is very unusual. Why has the mite developed such an elaborate system to inactivate complement pathways? This question fascinated Dave and his colleagues.

Scabies infection increases the risk of pyoderma caused by *Streptococcus pyogenes* and subsequent sequelae. Dave and I (KS), sometimes with our laboratory colleagues, used to go to the pub for lunch on most Fridays. At one of these 'pub meetings' I suggested that complement inhibition by the mite's inactive serine proteases could provide a congenial environment for bacteria such as *S. pyogenes* to grow in the skin burrows, thereby causing pyoderma and other skin infections. We decided to test this. This was exactly what was shown in our last co-authored paper [147].

Finally, in collaboration with Katja Fischer, Kate Mounsey, James McCarthy and others, Dave successfully established a pig model for scabies infection [143]. This vital step now helps in the screening for novel anti-scabies compounds, a pursuit that has become important in the light of the possible emergence of resistance to available agents [136].

Dave Kemp the Man

Dave was a caring, sharing and generous person. Indeed his colleagues Katja Fisher and Gabby Falls, his long-term research administration colleague at Menzies and great friend to Kath and Dave, recall that every time he returned from meetings or other trips he would ask caringly 'how are things in your neck of the woods?' or 'Is everything totally under control?'. Indeed his

group at Menzies had coffee mugs with pictures of all the laboratory members on it and saying: 'Yes Dave, everything is totally under control'. When we were applying for a Program Grant from NHMRC in 2003 (a major grant where many senior scientists join together for a collaborative grant), there was a unanimous decision by all involved that Dave should be the lead applicant. The application was successful and Dave was a highly committed and inspirational Program leader. The day he heard, after he had retired, that Katja Fischer had won personal support and grants to continue scabies research, it was difficult for him to control his feelings of pure joy—such was Dave, a person who cared deeply for his colleagues, staff and friends.

Dave received many awards. The list includes the Boehringer-Mannheim Medal of the Australian Biochemical Society (1981), the Wellcome Prize for diagnostics (1992), a Medallion from Menzies for his outstanding services to the School, a Centenary Medal (2003) and a Medal in the Order of Australia in the General Division (OAM) (2008). He was a Fellow of both the Australian Academy of Science (elected 1996) and the Australian Society for Parasitology.

Although Dave was a very high-achieving scientist, it did not mean that he did not get nervous about interviews. MG remembers him saying that the best thing for an interview was a good stiff drink. However, this almost backfired on one occasion. Dave was flying to Melbourne for a Fellowship interview and the plane had to be diverted to Adelaide because of bad weather. Dave managed to get the pilot to phone the NHMRC and explain his predicament. The pilot also suggested that Dave have another drink to calm his nerves! He finally arrived in Melbourne on a delayed flight and was interviewed late but of course was successful in his Fellowship application.

Dave was scientist of the first rank, a straight talker, a talented musician and a great friend to many. As his colleagues at WEHI recorded: 'Whilst Dave Kemp was an exceptional scientist and contributed enormously to research, his contributions are much broader. He was a wonderful mentor and many of us remember fondly Dave's great love of science and joyful reactions when new results were revealed "hot off the developer"'. Dave often commented that 'we have a great life as we are paid to come to work and play'. That was the ethos that he brought to his research and it was infectious, making his laboratory a great place to work in. He didn't operate a hierarchy, but led with insight, informality, respect and humour' (http://www.wehi.edu.au/about_us/history/a_tribute_to_dave_kemp/; Cowman *et al*. 2014) (Figs 2, 3). Yes, humour—Dave was the only person I (KS) have known who referred to chickpea curry as a 'weapon of mass destruction'. Graham Mitchell has this to say:

> Dave's good humour is an enduring memory. He collected Australian stories that were characterised by our unique larrikinism and terminology. One of his favourites was his experience, I think at Albury airport soon after his return from Stanford, where an aggressive would-be passenger was insisting on a seat on the flight to Melbourne. After a tense time with the man at the check-in counter using all possible variations of 'there are simply no seats available', the man finally said, 'listen Ocker, the Fokker's chocker' – a wonderfully definitive Australian statement that Dave enjoyed recounting. He had many more from various football matches in Melbourne and country pubs whilst engaged in yet another great passion, rock hunting. He also introduced us to the concept of the 'spouse-acceptability factor'. When we were deciding to stay back in the lab into the evening for whatever reason, Dave would declare that if he didn't get home pronto his spouse-acceptability factor would take a hit! Made us all think of our own spouse-acceptability factors.

In 2006, Dave and Kath moved to tranquil Tallangatta in north-eastern Victoria, where they were very happy. Once again this move was motivated by their dislike of large metropolitan cities. Kath died in 2012 and Dave never really recovered from that jolt. When Geetha and I (KS) visited him in Tallangatta, he said that he had achieved what he could in his lifetime and that he had had a good wicket, but he had no real desire to live long. It was very sad. Not long before he died, he asked us to enter him in our laboratory sweepstake on the Melbourne Cup. His horse won: I (KS) still owe him $2.

Bart Currie, who collaborated with Dave during the last two decades of his life, writes: 'Dave's impact at Menzies was profound, with his practical approach to issues of Indigenous Health showing just how important biomedical research is in addressing critical questions'. As

Figure 2. A jubilant Dave Kemp.

John Mathews put it 'Dave Kemp was a wonderful scientist and a friend; he lived life to the full, and the world is diminished by his premature death.' Dave died on 22 November 2013. He is survived by sons Andrew, Ben and Daniel and grandchildren Rachael, Jessica and Ryan.

Acknowledgements

We thank Dave's sons Daniel, Andrew and Ben for providing insight into Dave's early life. We are also grateful for contributions made willingly by many of Dave's colleagues, friends and

Figure 3. Dave Kemp test-riding an electric bicycle designed by the spouse of a laboratory staff member.

collaborators including Sir Gus Nossal, Professor Graham Mitchell, Professor Alan Cowman, Professor Suzanne Cory, Associate Professor Lynn Corcoran, Professor John Mathews, Professor Bart Currie, Dr Katja Fischer, Dr Al Yonovitz, Dr Vicki Krause and Mr Jon Hartas. Gabby Falls, Geetha Sriprakash, Deborah Holt, Sue Hutton and Frank Gannon helped with editing.

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