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Albert Russell ('Bert') Main 1919–2009

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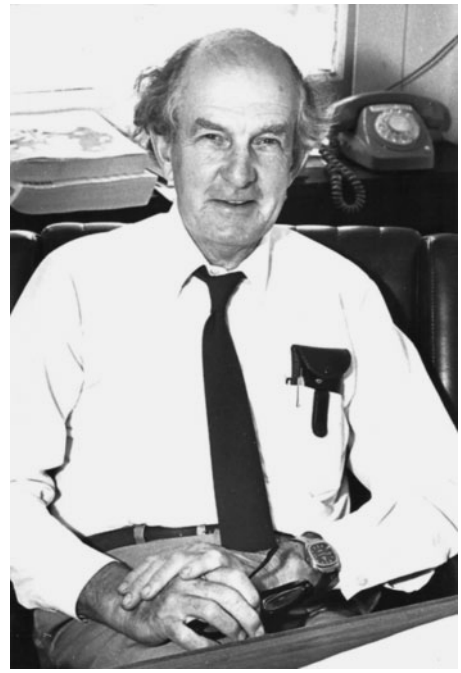
Bert Main (1919–2009) was recognized both nationally and internationally as one of Australia's leading zoologists and a gifted naturalist. His research and ecological teaching on a wide variety of animals, including frogs, reptiles, birds, insects and marsupials, laid the foundations for three generations of graduate students who were inspired by his imagination and biological insight. His foresight and energy as an administrator on government bodies also led to the creation of some of Western Australia's most important National Parks and Nature Reserves that are vital for the preservation of Australia's rich biodiversity and form part of his enduring legacy.

Introduction

Bert Main died peacefully on 3 December 2009 after a period of failing health. With his passing, Australia has lost one of its pioneer ecologists who went on to translate his knowledge of the country's rich wildlife into practical methods and means for its long-term preservation.

As one of his international collaborators, Professor Bill Dawson, commented from Michigan:

> I was impressed with the range of Bert's interests, which extended from conservation and ecology to marsupial nutrition, and with his eagerness to incorporate the latest techniques and approaches into his research and that of his graduate students. Bert Main had a significant beneficial impact on my scientific career due to his generosity and broad outlook. These qualities contributed to his and Harry Waring's establishing the Department of Zoology at the University of Western Australia as a sought after research destination for overseas biologists.



Bert was appointed as a Lecturer in Zoology at the University of Western Australia (UWA) in 1952 on the recommendation of the then Professor, Harry Waring, before his receiving his PhD on frog systematics and evolution in 1956. He was promoted to Reader in 1961 and awarded one of UWA's first Personal Chairs in 1967. Bert's primary research was on Australian frogs and their evolution but he was first and foremost a superb naturalist; his knowledge of the Australian flora and fauna in its natural and geohistorical setting was extraordinarily wide-ranging. This led him to supervise over thirty postgraduate students on organisms ranging from blennioid fish to tortoises, dragon lizards, marsupials, mountain ducks, arthropods and pitcher plants, as well as on the effect of phenomena including fire on the biota. From his earliest days, Bert believed in taking science to the public. He was a member of the Western Australian Naturalists' Club and his first publication in 1947 (1) was on the artificial propagation

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of the parasitic Christmas tree, *Nuytsia floribunda*. He was very active in Club affairs in the 1950s and his commitment to enthusing others about natural history and ecology is reflected in the publication, in 1954, of two of the Club's early Handbooks (7, 8), followed by *The Frogs of South-western Australia* in 1965 (36) and a revised and updated edition of Handbook No. 4, *A Guide for Naturalists*, with Don Edward in 1968 (48). He also convened, with Dom Serventy, an extensive appraisal by WA Naturalists' Club members of Kings Park as an indigenous nature reserve. This was published in 1957 and now provides an important early record of Perth's most important bushland remnant (17).

Early Years

Bert was born on 6 March 1919 in Perth and spent his childhood at Caversham in the Swan Valley, an area that was then close to undeveloped bushland. He was the eldest of three children, having a sister, Beth, and a brother, Keith. He credited his maternal grandfather, Albert Mylam, with having given him a love of the bush by taking him regularly on long walks. Bert's father, Alexander Russell Main, had been gassed in the First World War and, despite a back injury, maintained a small vineyard in the Swan Valley with the help of Bert's mother, Agnes (née Mylam). The vineyard was, however, sold and the family moved to Bassendean where Bert attended Midland State School and took the Junior Examination in 1934. His first job, at the age of 15, was as a messenger boy in the Department of Agriculture in East Perth, rising to become an assistant to several of the officers, helping them with filing and, among other tasks, sorting seeds. His career with the armed forces started at the age of 18 when he enrolled in the Citizens' Military Force (CMF), better known then as the 'Reserve' or 'Militia'.

War Experiences

Bert was marked for life, both physically and mentally, by his wartime experiences, which ended with him as an inmate in a German prisoner of war (POW) camp. After the outbreak of war, he transferred from the CMF to the 11th Infantry Battalion of the Australian Imperial Force in February 1943 as WX27804. Bert remarked later that the mindless routine of army life was not for him, leading him to enlist in the Royal Australian Air Force instead, where he became a Flight Sergeant and later a Warrant Officer (No. 436589). His early training as a navigator was in South Australia from whence he was transferred to Wolverhampton in the UK to continue his training. He commenced flying operations over Europe in 1944 as a navigator in Lancaster bombers. His aeroplane was shot down over Germany early in 1945 but he and the other crew members were able to parachute from the burning craft. Bert strained his back on landing and spent the next week scrounging for food and attempting to get to relative safety in Holland. Contrary to standing instructions, he hid one night in a farm haystack because of the intense cold: aircrew were told expressly not to seek refuge in haystacks as these were a favourite target of strafing fighters. Unfortunately, the farmer on whose land he was, discovered him the next morning and rendered him to the German authorities. He was taken as prisoner No. 146708 to Stalag VII/A, a POW camp located north of the town of Moosburg in southern Bavaria. The camp covered an area of 35 ha and served also as a transit camp through which prisoners, including officers, were processed on their way to other camps. At the time of its liberation in late April 1945, there were 130,000 prisoners from at least twenty-six nations on the camp roster. It was the largest POW camp in Germany. However at any time up to 60,000 were located in *Arbeitskommando*, repairing railroads or working in factories or on farms. In the main camp, over 40,000 prisoners were crowded into a space designed for 10,000.

Bert's stay in the camp was not long but one can gauge the conditions from the fact that his weight fell from his normal 12 stone (76 kg) to a little under 7 stone (43 kg) on his release. In the camp, Bert managed to fashion a knife and spoon (Figure 1) that he used to apportion rations to the fourteen inmates in his hut. Why Bert was given this responsibility is unclear, but he maintained it was because he was the only one who had a knife and that ended any arguments! His daily task was to divide the single 1 kg loaf of bread into fourteen equal portions. Kent Williams, one of Bert's PhD students relates a story that Bert repeated many times:

> Bert told us of his skill at slicing very even slices of bread. In his P.O.W. hut he assumed leadership he said, because he made himself a

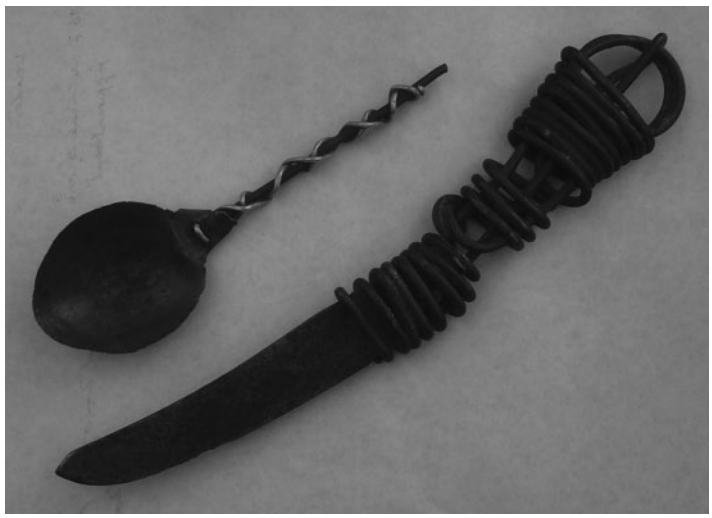

Figure 1. The metal spoon and knife fabricated by Bert Main when a POW in Stalag VII/A in Germany (Photo courtesy Barbara York Main).

knife from a piece of metal; I don't know where he obtained the metal from. The fourteen men in the hut were provided among them with one loaf of bread and a few ounces of meat per day. Bert used his knife to slice the bread into fourteen even slices in front of all the gathered inmates. The end pieces were rotated among the men on each occasion because it was agreed that they were denser than the inner slices. Bert laid out all the slices and then asked whether all agreed that the slices were even and fair. He adjusted for any claimed discrepancies by cutting pieces from some slices and adding to those considered smaller. He continued this process until all finally agreed that the portions were as fair as could be achieved. Then the men drew straws for the various inner-sliced portions.

Return to Australia

On being repatriated, Bert first spent time at a rehabilitation hospital in Yanchep, Western Australia, recuperating from a duodenal ulcer provoked by the lack of food in the POW camp. This was to dog him for years afterwards and I well remember the hundreds of tins of Belladonna that he emptied and we then used as temporary housing for frogs and lizards in the field![1]. He returned to his old position with the Department of Agriculture and matriculated at night school from the City Commercial College, being Dux of his year in 1946. Along with many other POWs, he benefited from the Commonwealth Reconstruction Training Scheme (CRTS), established to assist returning servicemen, which enabled him to enrol at UWA in 1947, in G. E. Nicholls' last year as Professor of Biology. The following year, Harry Waring arrived from the UK after being appointed to the newly created chair of Zoology.

Bert's undergraduate record was outstanding with distinctions in all subjects, and he graduated with First Class Honours in Zoology in 1952 after completing a double major in Zoology and Geology—the latter of which would play an important part in his understanding of plants and animals throughout his career. Bert's Honours thesis, which was nominally supervised by Harry Waring, was surprisingly on 'The role of the central nervous system in the locomotion of the lamprey, *Geotria australis*'. My recollection from talking to Bert was that he was interested in a group of neurones known as Rohon-Béard cells that are thought to derive from the neural crest (Nakao and Ishizawa 2004). They are primary sensory neurones that undergo apoptosis and only exist temporarily in fish and amphibians but persist in lampreys. He described their interaction with the automatic swimming behaviour

[1] Miraculously, his ulcer was to be cured many years later after being treated with heavy doses of antibiotics for another problem. He had almost certainly been suffering from *Helicobacter pylori*.

of *Geotria australis*. Unfortunately, his thesis has been lost and no publication came from the work.

Bert was awarded a Fulbright scholarship in 1950 to study in the USA and left to take this up before he had completed his Honours thesis. He studied at the University of Chicago under Tom Park and Sewell Wright, the latter greatly influencing his thinking on genetics. He also met and was befriended by the 'greats' of ecology and evolution of the time, under some of whom he studied—George Gaylord Simpson, Theodore Dobzhansky, Warder Clyde Allee, Alfred Emerson, Karl Schmidt and Orlando Park. On his return trip to Australia, Bert travelled via the UK and visited Charles Elton's Bureau of Animal Population in Oxford where he also studied with Arthur Cain and E. B. Ford, with whose ground-breaking work on polymorphism he was impressed. Bert returned to Western Australia late in 1951 and hurriedly put together and submitted his Honours thesis, for which he was awarded First Class Honours before being appointed to a lectureship in Zoology under Harry Waring.

Bert had met Barbara York as a first-year student in Zoology in 1947 and they were married on 12 April 1952. Barbara went on to have her own distinguished career as a zoologist—focusing on trapdoor spiders on which she became a world authority—and as a creative writer of distinction.[2] Bert and Barbara had three children, Rebecca (born 1956), Gilbert (1960) and Monica (1963). None has become a professional zoologist, but all have a deep love of nature and the environment that they owe to their parents. Daniel Brown, a life-long friend of the family, gives some insight into the Main family in the following:

> I first met Bert Main in 1981, through his daughter Monica. I was in the third year of my BA at the University of WA. He and Barbara were standing on chairs in the corner of their dining room scrutinizing the private life of a couple of house-spiders. Subsequent invitations to lunch, in full view of these animals, introduced me to further aspects of this life lived through science … through Bert's work as an ecologist with State and Federal governments and Barbara's literary and artistic work, subtle accounts of human social and historical interactions with regional biology and geology that Bert often talked of proudly. From talking with him over the years I gained the impression that Bert was surprised, even quietly astonished, by his life after the War – delighted by his research work and his family, proud of the individual and independent paths taken by his children and grandchildren.

Amphibian Research

Bert's PhD thesis, submitted in April 1955, was entitled 'Some aspects of the evolution and speciation of the Western Australian fauna as illustrated by the genus *Crinia* (Anura, Leptodactylidae)', and was a slim volume of some eighty-seven pages. It is noteworthy that he was already focused on the Australian fauna, and frogs were merely being treated as a case study. He deliberately chose frogs as his object of study because

> I had formed the view that because of the unprotected nature of their skin, frogs would be useful organisms in evolutionary studies as it was believed, at the time, that speciation in some of the biota had been promoted by a great aridity in the geologically recent past (99).

His Fulbright scholarship in 1950–51 to the University of Chicago was pivotal in focusing Bert on questions of evolution and their genetic basis. Prior to Bert's work, the literature on the identity of local frogs was confused, with the only two experts, Loveridge and Parker, disagreeing (Loveridge 1935; Parker 1940). Confusion over two species, *Crinia georgiana* and *C. signifera*, turned on the so-called 'flash colours' in the groin of *C. georgiana* that were said to be 'fast' (i.e. retained) in alcohol-preserved specimens but 'fugitive' (i.e. lost) in formalin-preserved specimens. Bert noticed, however, that the colours were lost when prior-killed specimens were preserved in either formalin or alcohol and the character was thus unreliable.

Bert chose to attack the problem of species identity using two different techniques—by recording and analysing the 'advertisement calls' of breeding males, and by using John Moore's technique of *in vitro* crosses of male and female gametes (Moore 1946) to identify interbreeding groups, based on Ernst Mayr's recently enunciated biological species concept (Mayr 1949). His

[2] See, for example, Main, B.Y., *Between Wodjil and Tor* (Jacaranda Press, 1967).

first student was Murray Littlejohn who tackled the problem of recording and scientifically analysing the breeding calls of the male frog. Murray comments:

> I had previously acquired a background in practical electronics as a hobby, and so gladly took up Bert's suggestion that for a BSc Honours project I might carry out a study of the structure and systematic significance of the calls of south-western Australian frogs through acoustic recording and analysis. The recent advances in the technology of tape-recording meant that such an approach to a field study of these calls seemed to be realistic, and Bert thought that the techniques could allow the resolution and identification of cryptic species of frogs, with the potential to increase the understanding of acoustic communication and its role in speciation. The feasibility of such an approach was realised through a preliminary field recording trial, carried out late in 1953 with the assistance of the Australian Broadcasting Commission. My Honours programme, supervised by Bert, commenced in the autumn of 1954, with the availability of a 'portable' tape recorder and a cathode ray oscilloscope and recording camera. Several field trips in south-western Australia with Bert were made during 1954, allowing us to obtain tape recordings of many species over a wide area of the south-west. An early paper which I co-authored with Tony Lee represents our first effort at reporting on the scientific application of the technology (Littlejohn and Lee 1955).

Bert's research on the amphibian fauna of Western Australia was ground-breaking. New species were discovered and described using the new methodology based on male calls (7, 9, 13–15, 18, 19, 21, 22, 24–26, 28–36, 38, 40), the work culminating in a major review paper on the ecology, systematics and evolution of Australian frogs (45). These papers alone would have been enough to cement his reputation as one of Australia's leading herpetologists and provided the basis for his election as an Honorary Foreign Member of the American Society of Icthyologists and Herpetologsts (ASIH) in 1975.

One of Bert's most important and influential papers on amphibian ecology and evolution appeared in 1958 with Murray Littlejohn and Tony Lee in the international journal, *Evolution* (19). The paper attempted to resolve the paradox of why there are so many more species of frogs in western than in eastern Australia, despite the topographic monotony of the Western Australian landscape and the absence of obvious barriers to gene flow such as rivers and mountains. All conventional theories of speciation at the time were based on allopatric separation of gene pools by physical barriers, and the Western Australian situation flew in the face of this. In this paper, the authors identified multiple species in the genera *Hyla*, *Neobatrachus*, *Heleioporus*, *Crinia* and *Pseudophryne* with corresponding species pairs in the eastern states and then erected a novel hypothesis based on successive migrations of frog species during wet (pluvial) periods of the Pleistocene. This hypothesis 'envisaged Western Australia as a peninsula from which the fauna of south-eastern Australia is now isolated by desert but into which components of the south-eastern fauna could migrate when the intervening country was less arid than it is now' (45). Bert's very original hypothesis was inspired by the early work with birds of Serventy and Whittell (1951) and based on the series of ice ages in the northern hemisphere that were translated into wet pluvial periods in southern Australia, when eastern and western Australia were joined across the barren desert area that is now the Nullarbor. If one took the basic eastern species in any one genus and multiplied by the three postulated migrations, one ended up miraculously with the number of species in the west!

This was indeed a novel hypothesis to explain the extraordinary richness of the Western Australian frog fauna and it was extended to apply to other speciose groups such as tabanid flies (Mackerras 1962), trap-door spiders (Main 1962), and reptiles (Horton 1972; Rawlinson 1974). It was vigorously attacked some two decades later, however, by Dale Roberts, who, working with Linda Maxson in the USA, used micro-complement fixation of albumin (MCF) to date lineages and concluded that an *in situ* speciation model was adequate to account for the lack of geographic barriers in south-western Australia (Maxson and Roberts 1984; Roberts and Maxson 1985). The subsequent refutation of molecular clocks on which their work was based (Baverstock *et al*. 1991; Gillespie 1991), and the uncertainty of serum albumin as a reliable indicator of phylogenetic relationships (Hass *et al*. 1992) has, however, cast doubt on their *in situ* explanation (Littlejohn *et al.* 1993). The hypothetical model of taxonomic divergence giving

rise to species groups within three taxa in south-eastern Australia (Watson and Littlejohn 1985), reviewed in a paper by Roberts and Watson (1993), concludes that this provides 'a substantial body of evidence to refute the view put by Roberts and Maxson (1988)'.

If the measure of an hypothesis is its ability to stimulate thought and further research, then Bert's on the evolution of Australian frogs has certainly stood the test of time! David Horton reflects on Bert's influence during his time as an Honours student in the Department of Zoology in 1965:

> Here was someone, it seemed, who knew how the world worked, and he could inspire you to hope that one day you too might understand those workings. He gave me to understand that ecology was a branch of biology with considerable intellectual content, a subject worthy of study and investigation, a mental challenge. Bert changed all that within days (it seemed) of me arriving in second year. And finally Bert's work on frog evolution in the south west with Tony and Murray was the single paper that inspired me the most. Here was a new way of looking at speciation, and a wonderfully simple and elegant way of describing an evolutionary sequence, and an introduction to the complex changing climate and geography of ancient Australia (a world I was barely, if at all, aware of previously). I was hooked. Bert Main was the person who lit my academic spark, and while many others blew on that spark and added to it in various ways, both then in WA and later, I will always remain grateful to him.

In 1958 Bert was awarded a Carnegie travelling fellowship and he and Barbara left for the USA with their 15-month-old child, Rebecca (Figure 2). After a brief stay in Vancouver, they travelled to Los Angeles to meet George Bartholomew who had been in Perth earlier, studying temperature regulation in the Rottnest quokka and who was interested in the interplay between behaviour and physiology in enabling animals to survive in deserts. Bert was very interested in past climates and had been collecting cores from long-lived *Callitris* pine trees in Australia, and he took these with him to Arizona to discuss them with dendrochronologists working on western junipers and other long-lived species. Bert and Barbara then went to Frank Blair's laboratory in Texas, where Bert met up again with Ernie Lundelius whom he had known as a

Figure 2. Bert and Barbara Main in the Zoology Department of the University of Western Australia in 1956 (Photo courtesy UWA Zoology Department Archives).

postgraduate student in Chicago. Ernie was now an established palaeontologist who was to spend many years in Australia, commencing in 1954 after being influenced by Bert to apply for a Fulbright fellowship. His studies on fossil remains have added immeasurably to our understanding of past climatic changes and faunal extinctions in Australia (Lundelius 1963, 1983).

Bert and Barbara then went to Duke University in North Carolina to meet up with Knut Schmidt-Nielsen who had earlier been to Perth to study some of Australia's 'strange' animals. This was followed by visits to Harvard, the Smithsonian Museum in Washington and the American Museum of Natural History in New York. Here they stayed in John Moore's apartment while the Moores were in Florida—showing that Bert's resolution of Moore's taxonomy of the Australian frog fauna was well received!

Bert and Barbara returned to Australia via the UK where Barbara's fellowship from the Australian Federation of University Women enabled them to spend time in the British Museum (Natural History)—now the Natural History Museum—in London. Here Bert studied type specimens of frogs and reptiles whilst Barb concentrated on the spiders. Barb relates that Bert

Figure 3. (Left to right) Bert Main, Ernest Hodgkin, Harry Waring and Knut Schmidt-Nielsen standing by the Zoology Department's DeSoto field vehicle in the late 1950s (Photo courtesy UWA Zoology Department Archives).

refused to travel to Germany where she wanted to see some spider types—this was understandable given Bert's experiences as a POW—and the types were all posted to her for examination in London. A visit to Oxford strengthened a lasting working friendship with ecologist Eric Duffey. In early 1959 they arrived back in Perth after a three-week boat trip, just in time for Bert to lecture to me as a first-year zoology student.

Marsupial Research

Harry Waring (Figure 3), on his appointment to the Foundation Chair of Zoology at UWA in 1948, was amazed that many Australian biologists at that time showed little interest in their native fauna and he initiated studies on the marsupial quokka wallaby on Rottnest Island. From this beginning flowed a series of graduate students who went on to work in almost every university in Australia and to establish the field of marsupial reproductive biology and ecology. Bert was a late convert but, by the 1960s, he had begun to work on kangaroos in the arid Pilbara region of Western Australia. Harry had secured recurrent funding from the CSIRO and there was a perceived problem at the time with a preponderance of euro kangaroos (*Macropus robustus*) in the pastoral regions of the State.

Sheep numbers in the Pilbara had been slowly declining since a series of major droughts in the 1940s, and kangaroo numbers were in plague proportions on some properties. The CSIRO initiated behavioural studies in an attempt to poison the large numbers of euros on sheep stations south of Port Hedland, but they found to their consternation that, although some individuals drank at wells every day, others only did so weekly and a significant fraction of euros never drank at all.

This spelt doom to a project based on the superficially reasonable concept of poisoning the euros that came to drink each night at water sources, since the animals were clearly not behaving according to the text books! Bert, on the other hand, saw this as a wonderful opportunity to study the importance of individual variation in a field population of marsupials and speculated that this could be an instance of 'evolution in action'.

Thus began a series of exhausting field trips to Mundabullangana Station (Munda), south of Port Hedland, over several years, shooting and studying the physiology of euro kangaroos in an attempt to unravel the mystery. I joined several of these heroic field trips, first as an Honours student and then as a PhD student of Bert's in the 1960s. The bitumen on the road to Port Hedland

ended at Carnarvon, some 1,000 km north of Perth, and after that it was corrugated gravel roads for another 1,000 km with gates across the highway. Our Landrovers were neither air-conditioned nor dust-proof and, after a long hot day, as we headed for a road-side camp-site, we all resembled dust-covered and sweat-drenched visitors from Mars. Bert's idea of choosing a camp-site was also novel. When the sun hit the horizon, he swung the wheel and that was it. This explains how, one night, we were woken by a terrible noise and a blinding white light, to find that we had bedded down immediately adjacent to a railway line!

Most of the field work went on at night, locating and shooting euros and collecting samples (blood, saliva, urine, faeces, kidneys, rumen contents, etc.) for analysis, all of which had to be stored, frozen in dry ice, for eventual return to Perth. Invariably, the dry ice ran out and the samples thawed, as we faced the reality of trying to do ecophysiological studies in 45° C heat in mid-summer. Throughout all this,
Bert was tireless. When we all collapsed with exhaustion in the early hours of the morning, Bert would still be going, planning the morrow's catch.

What emerged from this work was a fascinating story of how mismanagement of the pastoral leases had led to the exponential growth of the euro population in the Pilbara. The pastoralists typically burned the spinifex grasslands in summer when mustering their sheep for shearing, thus spreading the seeds of the flowering plants on to the burnt soil. Spinifex grasses (*Triodia* spp.) have a very low protein content, especially in summer, and historically had been restricted to the rocky hillsides where they were grazed by euro kangaroos that spent the hot days in cool, humid caves. The larger red kangaroo (*Macropus rufus*) inhabited the plains and river beds where there were high-protein grasses also favoured by the sheep. The number of reds had declined over the years as a result of competition with sheep but, unwittingly, the burning practices of the pastoralists had been spreading the spinifex grasses that are unpalatable to sheep. By the 1960s, spinifex grasses covered the plains where once red kangaroos had fed on high-protein native grasses, and with the spinifex had come the euro. Estimates of the euro population on Munda station went as high as 30,000 when the study commenced, compared with fewer than 13,000 sheep.

Unfortunately, few substantive publications emerged from this long-term field study, but Bert published a major paper in 1970 at a population ecology meeting in Holland (52) that laid the groundwork for his future thinking on the pivotal relationship between land management and conservation. His first visit to Barrow Island in 1969 (54) led to his viewing islands off the Western Australian coast, with their rich biodiversity, as simulacra for the reserves that needed to be created to protect the many native species now drowning in a sea of agricultural development and habitat destruction (47, 53, 72, 78).

In the 1960s and 1970s, Bert built up a stable of postgraduate students—Graham Brown (42), Shelley Barker (16), Bob Prince, Jack Kinnear (50, 60), Bill Holsworth, Glen Storr, Tim Ealey (37, 43), John Kelsall and John Sampson—all working on aspects of marsupial ecology and physiology and all of whom went on to have distinguished careers in zoology. Each of them was filling in one of the boxes in the endless matrices that Bert was always constructing—attempting to unravel the way in which different animals fit into and adapt to their environment. He was particularly interested in how the macropodid marsupials were able to survive and breed on the low-protein grasses characteristic of the arid zone and the way in which they treat urea as a nitrogen supplement, rather than purely as an excretory product (42, 46, 60).

My own case was rather different. Although I had approached Bert about supervising me for an Honours project on urea recycling in the marsupial kidney, he asked me what I knew about lizards. I told him 'nothing' and he said to take a picnic on a granite rock in the Perth hills and tell him what I saw. I did as instructed one summer's day and saw these amazing small dragon lizards whizzing around the bare granite rock in the stifling heat and immediately I started to wonder how they regulated their body temperature and where they got their water from. On my duly reporting this to Bert, he said that he was getting too old to chase lizards (this was in 1962!) and proceeded to give me a whole series of cards on which he had been recording body temperatures of lizards with a Schultheis quick-reading thermometer. Some of Bert's students may have felt that they were only filling in squares in one

of Bert's multi-factorial schemes, but for some reason I was left free to chart my own course and develop my own ideas (49), culminating in his not even reading my PhD thesis before its submission!

Teaching

Bert carried a very heavy teaching load in his early days in the Zoology Department, as I found to my cost when I replaced him as a Temporary Lecturer in 1965 during his sabbatical in the final year of my PhD. He lectured on all the invertebrate fauna, focusing especially on protozoa, coelenterates and platyhelminthes, all of which featured in his WA Naturalists' Handbook published in 1954 (8). He also lectured on vertebrates to first-year students and on ecology to second-years, and he ran an 18-lecture course on evolution, with associated field work, in third year. I was also nominally in charge of the four Honours students that year, Kent Williams (61, 62), Bob Henzell, David Horton and Mike Gray, all of whom went on to have very successful careers in zoology.

Although Bert himself was exposed to the Allee 'school' of ecology during his period in the USA (Allee *et al*. 1949), he was firmly of the opinion that ecology could not be taught, only discovered when one had some raw data in hand. He believed that slavishly following a text led only to the imprinting of students with one or other of the competing 'schools' of ecology current at that time (e.g. Andrewartha and Birch 1954). He was also firmly opposed to the supposed widespread influence of 'competition' as a major factor structuring animal populations that was all the fashion at the time (Simberloff 1984). The following comments by Rob Whelan, one of his PhD students, typify Bert and his approach to research:

> Perhaps my best lesson from Bert resulted from my first interaction with him, prior to embarking on the research. I presented him with a brief, written research proposal, and when I came to discuss it with him he said: 'What do you plan to do first?' I suggested that I should complete a thorough literature review before designing my first field experiments. 'No, no, no!' was his response. 'Get out into the field and get your hands dirty. Try something out, do some pilot studies. Whatever you do, don't let the current literature constrain your thinking. You can return to the literature when you have a "feeling" for how your system works.'

His ecology lecture course focused on a series of papers by Thomas Park and colleagues, dating back to the 1940s, on the outcome of competitive interactions between different species of flour beetles (*Tribolium*) raised in the laboratory (Park 1948). These publications, continuing into the 1960s, exemplified the complexity and hopelessness of predicting competitive outcomes in a rigidly controlled laboratory environment. As Bert would point out, if these could not be predicted with certainty, what hope did one have of predicting outcomes in the real, infinitely more complex, natural environment?

Bert as a teacher could be inspirational but not in the usual way, as seen from the following personal comments by Barry Wilson:

> In the early days when the Zoology Department was housed in the brick building up on the hill, Bert Main was regarded by most undergraduate students as a formidable figure. He was known to be intolerant of ineptitude and laziness. I copped a bit of that myself as an undergraduate – deserved of course – but I had known him before and knew that he offered more than the occasional disciplinary admonition. In the winter of 1957 Prof Waring had initiated a project on the quokkas of Bald Island, a remnant island population that makes a neat comparison to the much-studied one on Rottnest. Bert and I had come to investigate the feasibility of landing people and gear on the island – not an easy thing to do. When sitting out some windy weather one day, Bert said he had something to show me. We went back up the road a few miles and down the bush track to Wychinicup Inlet, a stunningly beautiful spot where a creek cuts through a ridge of granitic hills to the ocean. We struggled through dense scrub up the hill on the north side to its summit where we sat on a high gneiss boulder with a 360° view of the southern world
> that took away all the breath we had left. We sat there on that hill for more than an hour, while Bert talked about his interpretation of the whole landscape. His story was a kind of blend of biology and geology and meteorology that I had never considered before. It was about a world that was constantly changing on a time scale that was hard to comprehend but for which the evidence was laid out there in front of us. And it was about the capacity of life to adapt to change, to survive and come on again. It came as a sudden revelation to me that this was a creation story.

> But not creation as I had heard it told before. He gave me a world-life view. A teacher cannot give a student more than that.

My own experience of Bert's teaching was equally life-changing. I had been strongly influenced by my chemistry teacher at high school and entered university intent on becoming a research chemist. In first year I enrolled in chemistry, physics and mathematics and only took biology as a soft option to give me more time to concentrate on my 'serious' subjects. I have to admit that first-year zoology at UWA at that time was not challenging and I learnt little more than I had picked up in my high school biology course until the last four lectures of the course, which were on ecology and given by Bert Main. We were challenged by this thin young man in shorts and leather sandals, who sat on the dais in front and then proceeded to harangue us with unheard of things such as erecting life tables for quokkas based on collecting their skulls on Rottnest Island. None of us could understand a word of his four lectures and it was the first time in my young arrogant experience that I could not digest and command an idea or concept. The effect on me was cataclysmic. I rang up the professor, Harry Waring—on a Saturday morning!—and told him that I wanted to discuss my future career. He said straight off 'come around my boy' and I duly went to see him that morning in his house in Nedlands. When I explained that I had been overwhelmed by Bert's lectures and now wished to become an ecologist, he immediately mapped out a change in my intended enrolments and told me that I would need to study physiology, biochemistry and botany—all of which I did in my second year, abandoning chemistry to its fate!

Bert was not a 'good' lecturer in the sense that his lectures were crafted for his audience and enabled them to follow a clear track of reason. They were chaotic at times and hard to follow, but one always knew that there was something of value there—if only one could reach it! Shelley Barker, one of Bert's first PhD students, reflects on the impact that Bert's lecturing had on eager students:

> He was an inspiration and most of us were hooked and went on to 3rd year. In that year he lectured us in Ecology and I remember like everyone else I wondered what had hit me. Bert was an appalling lecturer, not in his presentation but in the content of his lectures. None of us knew what he was talking about as he lectured at a level far above the comprehension of his audience.

Karl Zwicky's comments as Head of Department on Bert's retirement from Zoology in 1983 were, as usual with Karl, very insightful and echo one of Bert's aphorisms, that 'learning was a process of accumulating scar tissue':

> Yet none of these Honours takes account of what I like to think of as his characteristic contribution to yet another field, that of educational theory. It is best summed up, and many would recognize the author, by his concept of 'scar tissue' – a mark of his keen and bracing impact on the receptive student: abrasive, distinguishing and unforgettable.

All of Bert's lecture courses were accompanied by field work and for our invertebrate lectures we were taken out to lakes and swamps around Perth and helped to identify the many protozoa, coelenterates, crustaceans and free-living platyhelminths and nematodes. There was also a spider course run every year in Kings Park, based on the trapping of lycosid spiders each winter when the males commenced moving in search of females. We were taught to manipulate the trapping data quantitatively, if somewhat crudely, given that the only calculators available at that time were hand-cranked Facit machines on which it took roughly twenty minutes to run a Student 't' test! The exercise started in 1959 and was still being run by Bert in 1970. The aim was to count the numbers and sex of spiders caught in small pit-fall traps, and to analyse the trap data in terms of the management of Kings Park that had involved controlled burning of the bush in late spring until 1963, after which burning was abandoned in favour of mowing the park verges to reduce the hazard of fires coming from passing vehicles. To quote from Bert's handout to students at the start of the exercise:

> The foregoing suggests that productivity and total population size is regulated by a complex set of interactions between seasonal weather and history of the area e.g. 'control' burning; no burning; accidental summer fires; cutting of timber etc.

This simple exercise was thus an introduction to the complexity of a real system and gave

us an opportunity of interacting with 'real' data. I always hoped that Bert would one day publish the results of this very original, long-term study but he never did. Perhaps most novel at the time was the third-year camp on Rottnest Island, run by Bert and John Shield, which attempted to link the two disciplines of population genetics and population ecology through a series of field exercises involving quokkas, buprestid beetles, reef-living whelks, sea urchins and two species of gastropods in the splash zone. The five-day course was followed by a written examination, on the island, that formed part of our final third-year mark. The camp was an outstanding introduction to the complexities of working with real populations, estimating population size and age structure and attempting to erect life and death tables, and they laid the basis for students starting research in Honours and a postgraduate degree. Not all was dull, however, as the following quote from Shelley Barker attests:

> There was a memorable trip when I climbed into an Auster airplane with the pilot, Bert and Ted Walshe [the departmental photographer]. We had flown to the west end of Rottnest and the pilot put the 'plane into a tight turn to port around the end of the island while Bert hung out of the side door of the 'plane taking photographs with an aerial camera while I held tightly onto his legs. This was probably the craziest stunt I've ever been involved in!

Understandably, Bert's involvement with and activities in the Zoology Department at UWA diminished as his involvement with Government grew from 1970 onwards and his lecturing was taken over by other staff. He continued to supervise postgraduate students, however, with Dave Algar and Sally Clarke being his last, gaining their degrees in 1986, three years after his retirement.

Community Service

Bert's extraordinary involvement in the practical application of science to the problems of environmental management in Western Australia commenced in the late 1950s and continued long after his retirement from UWA in 1983. His work focusing on the protection of wildlife commenced as a member of the state's Fauna Protection Advisory Committee (FPAC), and developed through his membership of the Western Australian sub-committee of the National Parks Committee established by the Australian Academy of Science (AAS) in 1958. The report from this committee, 'National Parks and Nature Reserves in Western Australia', published by the Academy in 1965, recommended the creation of what are now Western Australia's best known and most important national parks and nature reserves—Prince Regent Nature Reserve, Karajini (Hamersley Range) National Park, Great Victoria Desert Nature Reserve, Nuytsland Nature Reserve and Drysdale River National Park (AAS 1965)).

The FPAC was replaced by the Western Australian Wildlife Authority in 1968 and Bert became a founding member, continuing in this role until the Authority was superseded under the Conservation and Land Management Act of Western Australia in 1985. He was also a foundation member of the Western Fisheries Research Committee, established by the Western Australian Government in 1959 to regulate all commercial fisheries in the State. Bert's role here was regularly to review and evaluate all research proposals by staff of the then Department of Fisheries and Wildlife.

As if this were not enough, Bert became a member of the Australian Universities Commission (AUC) from 1971 to 1977 and was heavily involved in the expansion and equipping of universities throughout the country that followed somewhat belatedly from the recommendations of the Murray Report. He was also a Council Member of the Australian Institute of Marine Science (AIMS), located in Townsville, 1972–77, and was still involved in committee work at UWA, as Jack Cannon recalls:

> I first met Bert when we served on the University Research Committee in the days before the ARGC. Bert was a realist who wanted to know how previous grants had been spent before approving the next request for funds. He certainly did not tolerate fools gladly but, on the other hand, he was sympathetic to young academics and helped them to submit better proposals. He also encouraged research in new fields of study, such as providing electronic equipment to the Department of Music and supporting the emerging field (at that stage) of Human Movement. He was also very keen to encourage interdisciplinary research and succeeded in recruiting me to provide some chemical skills to problems involving marsupials and lizards.

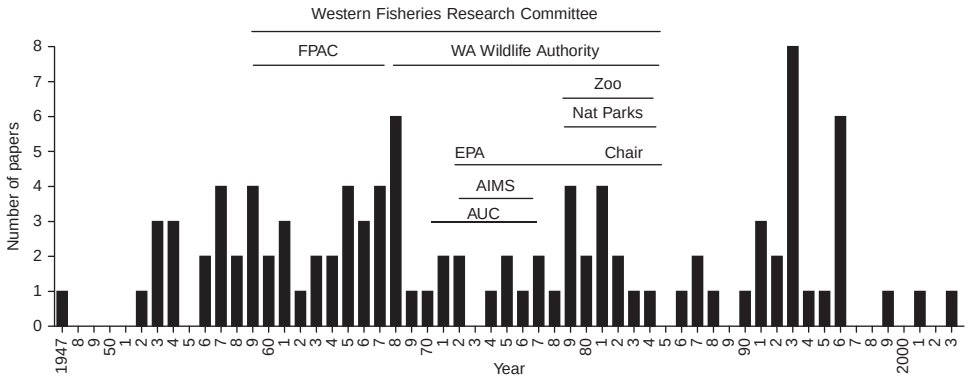

Figure 4. Bert Main's publications listed by year, with details of community service.

Bert's most important contribution, though, was undoubtedly as a founding member of Western Australia's Environmental Protection Authority (EPA) that was established in 1972, becoming its Deputy Chair in 1981, then Chairman from 1982 until his retirement in 1985 (Figure 4). One of the EPA's first decisions was to set up a Conservation Through Reserves Committee (CTRC) that ultimately resulted in the creation of numerous reserves, including Rudall River, Peak Charles, d'Entrecasteaux, Shannon and Millstream-Chichester National Parks and Ningaloo Marine Park, and the enlargement of the Leeuwin-Naturaliste National Park. Bert was also appointed President of the National Parks Authority in Western Australia in 1980 and President of the Perth Zoological Gardens, 1979–85. For several years from 1989, he also chaired the Western Australian Greenhouse Coordination Council and truly it can be said that nothing to do with the environment could happen in Western Australia without Bert's involvement! Andrew Burbidge, one of Bert's PhD students, who went on to have an important career in conservation, comments on Bert's influence as Chair of the EPA:

> The EPA's main duty was to assess the environmental impact of development proposals. Since the Environmental Protection Act had 'teeth', this work often resulted in dealing with complex and controversial issues and in glaring publicity. Bert absolutely refused to be swayed or intimidated by pressure from lobbyists and politicians alike and was particularly unwilling to be rushed into quick decisions. As a result the Authority quickly developed a reputation for fair and sensible recommendations and its decisions were generally accepted by most sectors of society. His encyclopaedic knowledge of the State, its biota and the ecological literature frequently amazed those with whom he dealt. It certainly never paid to argue with him unless you were on very sure grounds!

Nutrient Cycling and Ecosystem Theory

Bert was acutely aware of the extent to which the Australian arid zone is depleted of essential nutrients and of the importance of nitrogen in the metabolism of marsupial kangaroos and wallabies. This was reflected in the topics of the PhD theses of several of his students. Urea recycling was a focus of Jack Kinnear's thesis on the tammar wallaby (60) and this led to a novel hypothesis that was expounded in two papers in 1979 on niche theory and macropod nutrition (66, 67). Bert built on G. E. Hutchinson's concept of a species' 'fundamental' and 'realised niche', using this as a basic structure to explain how some marsupials, such as the quokka wallaby, *Setonix brachyurus*, was able to survive on Rottnest Island in a habitat totally different from that which it had occupied on the mainland (99). A long-time colleague from his Texas days, Ernie Lundelius, characterizes Bert's approach:

> Bert was a very critical thinker. He could be very hard on a weak argument but was always open to new ideas. He was also very good at keeping up with new ideas and information. Over the many years I knew him we could immediately exchange ideas as if we had not seen each other

for a few days. He was an outstanding scientist and a good friend.

In 1983, Bert was invited to introduce a symposium entitled 'Research on Rottnest Island' (Bradshaw 1983) that was scheduled as part of an Australian and New Zealand Association for the Advancement of Science (ANZAAS) meeting in Perth. His paper on macropod ecophysiology (77) shows the way his thinking was evolving to become a theoretical framework with which to tackle the practical problems of species conservation and environmental management. To quote his paper:

> Thus it would appear that ecophysiological capacities and habitat resources can be linked in a way which is potentially useful for devising management strategies, particularly if we think of the aims of management as being analogous to evolutionary success (77, p. 7).

What Bert came to refer to as the 'nutrient cycle' was central to his thinking about past and present functions of ecosystems in Australia and the role that plants and animals play in this (71, 75, 78, 80, 94–98). He used his knowledge of the geological past to develop an evolutionary scenario showing how complexity and stability had evolved over millions of years on earth and was now threatened by man's actions (108). In the simplest of systems, such as would have existed during the early stages of evolution of life on earth, ecosystems would have been composed of only prokaryote producers (nitrogen fixation and photosynthesis) and degraders. Once elaborated, however, these molecules (amino acids and carbohydrates) are a resource to be exploited by organisms that cannot in themselves elaborate them. Bert saw the evolution of a suite of consuming organisms (plants and animals) interpolated between the synthesisers and degraders as 'a device for delaying the ultimate degradation of biological material by bacteria, or increasing its residence time in the ecosystem before ultimate degradation' (71).

Mineral nutrients are also essential for growth and reproduction and these have a tendency to accumulate in places of their origin or to gravitate to sinks (e.g. bogs and lakes, or even long-lived vegetation and deep-rooted plants). Herbivores and predators can thus be viewed as devices for redistributing essential nutrients in an ecosystem, without which it will revert to a simple structure. Stable systems are thus those that maximize the retention time of expensive biological molecules within the ecosystem, and ones that possess several modes (redundancy) for the introduction, retention and redistribution of those nutrients. This is how Bert came to see the importance of rare species, as entities that might not be of importance in well functioning ecosystems, but that could be vital in the carrying out of essential services in systems depleted of complexity by factors such as recurrent fire, pathogens and habitat destruction (75, 78).

This was indeed a novel vision, linking ecophysiological studies with questions of ecosystem function and stability, and it was one that Bert was to use to great effect in tackling the questions of the badly degraded wheat belt area of Western Australia and the sustainability of current agricultural practices (94, 95).

Bert's approach to the many problems of restoring the wheat belt evoked a very telling analogy in one of his last papers from his wartime days as a navigator:

> My training as an aircraft navigator in the 1940s was based on the precautionary principle and adaptive management. Our task was to individually navigate our aircraft to target at night as one of perhaps hundreds in the bomber stream. The details of the target, the course to be taken and the winds and weather conditions likely to be experienced were given in a pre-flight briefing after which navigators prepared a flight plan. The goal was to arrive at target on course and at the designated time. We were taught to plan for the worst case scenario, which was that the winds and weather would not be as predicted, rendering our flight plans useless. To minimize this risk each navigator re-established the position of his aircraft every 6 minutes and if necessary altered speed and course so that the prescribed route was followed thus ensuring arrival at the designated time. The analogy between this experience and the problem of ensuring arrival at sustainable agriculture is apparent, but a strategy of adaptive management in agriculture is only possible if the decisions taken are based on knowledge of how the world, both physical and biological, is structured and likely to work.… To return to the analogy of the navigator, it is inevitable that the weather forecast will at some point be wrong, that the flight plan will become redundant and that to stay on track it will be necessary to constantly re-establish our position. What makes agriculture

> even more difficult is that there is no general agreement on the position of the target (106).

Conservation, Forestry and Reserve Management

Bert's interest in conservation was a life-long passion that developed early, as shown by the following quotation:

> While in the army I had been stationed on the sand plains west of Dandaragan and had become very aware of the immense floral and invertebrate species richness of these areas. In 1947 I attempted to have extensive sandplain areas reserved without success. The consensus opinion at the time was that these areas could not be used for agriculture and so would always remain as vacant crown land, and having them reserved would merely preclude other better areas from being considered for reservation. The fallacy of this reasoning became apparent as soon as it was realised that the agricultural potential could be enhanced simply by adding trace elements to the land (99).

Bert's involvement in Government was a direct response to this perceived need to establish reserves for the protection of Western Australia's rapidly diminishing wildlife. Very early on, Bert saw islands with populations of marsupials, such as Rottnest and Barrow Islands, as 'natural experiments' from which one could gauge the area needed to establish reserves that would protect a full complement of vertebrate, and particularly marsupial, species (27, 41, 53). Barrow Island, with an area of ~50,000 acres (22,250 ha), was taken as a templet for the minimum size for a reserve that was capable of maintaining a full complement of marsupials (53, 101). Richard Hobbs comments on how Bert's knowledge of the natural world underpinned all his research:

> Bert's great strength was an incredibly deep knowledge of the biota, acquired through many years of field observations, coupled with a keen sense of ecological ideas and approaches. No matter what subject, Bert always seemed to know something about it and have an opinion on it – and he was not averse to providing a contrary view or pricking over-inflated ideas, but always done with a sturdy sense of humour. Ted Lefroy once remarked that what we really needed to hasten progress in conservation and ecosystem management was to photocopy Bert so we could have multiple copies! I privately took on the task of trying to extract and record as much of Bert's wisdom as I could – and although I think we achieved quite a lot in that regard, one got the impression that there was always a huge amount more left untapped. His contribution to more conceptual and synthetic papers and chapters was always the crucial element that made the enterprise much more useful and meaningful.

Bert tackled the problem of managing remnants of native vegetation in the wheat-belt area of Western Australia in a series of thoughtful papers based on his theory of ecosystem evolution and function developed in relation to the nutrient cycle and the roles played by rare and abundant species (80, 88, 89, 94, 95, 97, 98). Restoring what is one of the most devastated ecosystems in Australia was always going to be a big task, but Bert tackled it with his usual systematic approach. He reviewed the problems and suggested an approach based on the restoration of essential ecological services now lacking because of the loss of biodiversity (80, 88, 90, 91). He argued that rare species were particularly important in the wheat-belt area because they now perform vital ecological services once carried out by a multiplicity of other species, long since gone—and this was Bert's main argument for their conservation (78). His categorizing nutrient response modes following perturbations such as fire, flood, drought and the uprooting of trees was particularly insightful and helped define the ecological poverty of the area now being cropped solely for cereal plants (80, Table 4).

> Any attempt to reverse the landscape trends now apparent require that it be managed in such a way that natural areas, revegetated and farmed together form a landscape in which the impaired or lost functions are restored (90, p. 189).

Bert's authority in all questions of ecology and conservation led to one of the few public disagreements of his career.[3] A provocative paper was published in 1994 purporting to justify, on basic ecological principles, the current intensity of logging and prescribed burning of forests in the south-west of Western Australia by

[3] Early in Bert's career he did write an article for *The West Australian* newspaper objecting to the impact on wildlife of the UK's atomic testing on the Monte Bello islands in 1952.

the then Department of Conservation and Land Management (CALM) (Abbott and Christensen 1994). Bert was co-signatory to a paper soundly debunking these claims (100), which evoked wounded cries of ideological bias from the original authors (Abbott and Christensen 1996). The fact that one of these authors had been supervised by Bert for his PhD only made the conflict more poignant. The dispute had an unhealthy side to it too, as the senior author of a second article criticizing the Abbott and Christensen paper (Calver *et al.* 1998) was subjected to considerable pressure in his university by officers from CALM, attempting to suppress any criticism of the then current forestry management practices. The end result of this is well known in Western Australia, with doctors and bankers picketing Parliament House against the logging of old-growth forests, and a change of Government in 2001. Bert's influential role in steering needed changes in the way in which the environment was treated by the Government is highlighted by Bernard Bowen's reflections, himself a Chair of the EPA some years after Bert:

> Bert's standing with the politicians of the day was legendary. This was never more evident than when there was a proposal for a large industrial project to be sited in the upper Swan wine-growing area. Bert was a member of the Environmental Protection Authority at the time. It was the early days of the EPA and it was also the early days of the 'big push' by governments of all persuasions to have development as their number one priority. The industrial proposal was found to be environmentally unacceptable to the EPA. This was probably the first time that environmental and industry values had clashed in a substantive way. The Premier of the day had carriage of the industrial proposal and thus was in direct discussion with the EPA, which had an advisory role to government. Such was the standing of Bert Main and the clarity of his overarching environmental explanations that the Premier decided, no doubt reluctantly, that the industrial project would not be allowed to proceed in the proposed area.

Bert also came to question the extensive burning of tracts of bushland each year by CALM, now the Department of Environment and Conservation (DEC). Approximately 200,000 ha are burnt annually in Western Australia, and emit on average some 200 tonnes of CO_2 per hectare, or 40 Mt per year (Slijepcevic 2001), with the expressed intent of reducing 'fuel loads' and the probability of wildfire in the National Estate. Prescribed burning evolved from the routine forestry practice of reducing competing vegetation in timber forests by the strategic use of fire. It has evolved, however, into a policy that also claims to maintain and even stimulate biodiversity—a claim that is challenged by many scientists working in the field.

In a paper published in 1996, Bert said that he wished:

> to explore the possibility that traits which are now of selective advantage in the present fire-prone environment could have arisen in response to past selection pressures different from those imposed by the fire disclimax resulting from Aboriginal burning practices (104, p. 99).

He then advanced a compelling case that many of the traits possessed by Australian plants that are thought to be fire adaptations—such as lignotubers, resprouting, large persistent woody fruits and scleromorphy—are in fact adaptive responses to stresses imposed by the low nutritional status of Australian soils. Such adaptations could have arisen as long ago as the Miocene and now function secondarily to enhance fitness in fire-prone environments. This argument has been echoed in a recent review by Bradshaw *et al*. (2011) who found little evidence for fire-adapted plant traits in Mediterranean climate regions.

In the second-last paper that Bert published, in 2001, he reported the results of a long-term study in the Western Australian wheatbelt of the interactions between a hepialid moth, a small sedge, and fire (107). The paper details a study extending back some thirty-four years (albeit including early undocumented observations) and reveals the complexity of interactions between the moth and the sedge on which it feeds and the unpredictable impacts that clearing and fire can have on this simple ecosystem. As Bert commented:

> The observations have implications for reserve management because they challenge the common assumption of successful retention within reservations.… It needs to be emphasized that being serious about conserving biodiversity involves considering more than just plants and vertebrates. Moreover, even simple systems are complex (107).

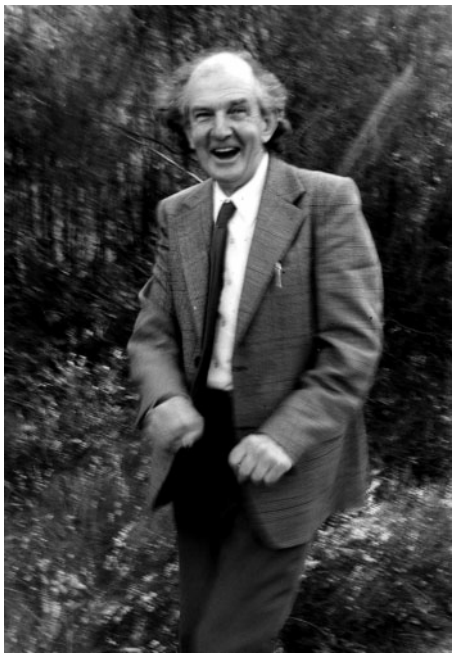

Figure 5. Bert in jocular mood (Photo courtesy UWA Zoology Department Archives).

Honours and Awards

Bert was a Fulbright Scholar in 1950–51 and received a Carnegie Travelling Fellowship in 1958. He was elected a Fellow of the AAS in 1969 and shared the Britannica Australia Award for Science in 1970 with Harry Waring, 'For their distinguished contributions to the ecology and conservation of Australian marsupials'. He was made an Honorary Foreign Member of the ASIH in 1975 and, in 1981, in recognition of both his public service and his scientific research, he was made a Commander in the Civil Division of the Order of the British Empire. He was made an Honorary Member of the Royal Society of Western Australia in 1982 and their medallist in 1995 (99). He was awarded an Honorary DSc from the UWA in 1987 and received the Ecological Society of Australia Medal in 1988. He was made a Fellow of the ANZAAS in 1985 and received the Association's von Mueller medal in 1990. Amongst Bert's many medals is also one from the Caterpillar Club—for servicemen and women whose lives were saved by parachutes—made of silk! Bert wore his medals lightly though (Figure 5), as a long associate, Harry Butler, reflects:

> Bert Main was one of my few heroes. An academic who could see the necessity for pragmatism in the scientific world. At a Museum function I saw him standing alone and went to say hello – his comment 'Good! Someone I can talk to without having to explain'. I miss him.

Conclusion

Bert Main was a most unusual and highly gifted man. He had humble origins but his impact on three generations of students was enormous and his legacy is there for all generations to see in the form of the numerous parks and reserves that he helped create. Bert did not suffer fools gladly, and he set out early in life to change the environment in which he found himself. In this he was extraordinarily successful, leaving us with the hope that the many environmental errors of the past are not irrevocable.

His memorable advice to young graduands in the midst of a mining boom in 1987, on the occasion of his receiving an Honorary Doctorate from UWA, was:

> For we live in a world ruled by accountants and tally-keepers, for whom form-filling is the peak of intellectual endeavour. Such ciphers have no knowledge of history, not any concept of how long it may be before pieces of information fall into place. It will need good presentation and outstanding advocacy to convince them that inquiry in the form of research must go on. That it is not possible to endlessly quarry established knowledge and theories for the quick fix and rapid monetary reward, an attitude which is so prevalent today. Such behaviour can be likened to a mining company which does no exploration until the lode currently being exploited has been exhausted.

Acknowledgements

Many of Bert Main's former students and colleagues have sent me details, photographs and recollections for which I am most grateful. I am also indebted to Barbara York Main for sharing some of the events of their rich life together. The portrait photograph shows Bert Main as chair of the Environmental Protection Authority (EPA) of Western Australia in 1983 (courtesy: Barbara York Main).

List of Graduate Students of A. R. Main (some co-supervised)

MSc

MILWARD, N. 1962 Systematics and biology of blennioid fishes in WA
WALKER, S. M. 1966 Phenotypic variation in the genus *Crinia*
RAMSAY, A. 1966 Nutrition in the quokka
GRAY, M. 1968 Trapdoor spiders: adaptations to aridity
LENANTON, R. 1971 Biology of whiting (*Sillago* spp) in Shark Bay

PhD

LITTLEJOHN, M. 1957 Isolating mechanisms in *Crinia*
GEORGE, R. 1958 Biology of *Panulirus longipes*
BARKER, S. 1960 Trace elements in the quokka
STORR, G. M. 1961 Nutrition in the quokka
EALEY, E. H. M. 1962 Biology of the euro
BROWN, G. D. 1964 Nitrogen requirements of macropods
HOLSWORTH, W. 1964 Population homeostasis in the quokka
BRADSHAW, S. D. 1965 Comparative ecology of lizards of the genus A*mphibolurus*
KELSALL, J. 1965 Insular variability in the tammar
LANE, W. 1965 Biology of some *Lycosa* species
LEE, A. K. 1965 Taxonomy, ecology and evolution of *Heleioporus*
BURBIDGE, A. A. 1967 Biology of south-western Australian tortoises
PUROHIT, K. 1969 Nutrition of the tammar
RIGGERT, T. 1969 Biology of the mountain duck on Rottnest Island
KINNEAR, J. E. 1970 Nitrogen metabolism of macropods
SAMPSON, J. 1971 Biology of *Bettongia penicillata*
WILLIAMS, C. K. 1971 Ecology of chats (*Epthianura*)
BAKKER, H. R. 1973 Water and electrolyte metabolism of the tammar
BULL, M. 1973 Interactions of two allopatric frog species at a common boundary
BLACKWELL, J. 1974 Deme structure in the frog *Crinia insignifera*
WHITE, T. 1976 Population dynamics of the tiger prawn *Penaeus esculentus*
PRINCE, R. 1976 Comparative nutrition and physiology in macropods.
CHRISTENSEN, P. 1977 Fire biology of *Bettongia penicillata* and *Macropus eugenii*
MORGAN, G. 1977 Population dynamics of the Western Rock Lobster
WHELAN, R. J. 1977 Influence of insect grazers on the establishment of post-fire plant populations
BAYNES, A. 1979 Late Quaternary mammal fauna from Hastings Cave, Jurien
WAKE, J. 1980 Field nutrition of the Rottnest Island quokka
CLARKE, S. 1986 Demographic aspects of the pitcher of *Cephhalotus follicularis*
ALGAR, D. 1986 Ecological study of macropodid marsupial species on a reserve

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