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Toxinology in Australia's colonial era: A chronology and perspective of human envenomation in 19th century Australia

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Abstract

The medical management of those envenomed by snakes, spiders and poisonous fish in Australia featured extensively in the writings 19th century doctors, expeditioners and anthropologists. Against the background of this introduced medical doctrine there already existed an extensive tradition of Aboriginal medical lore; techniques of heat treatment, suction, incision and the application of plant-derived pharmacological substances featured extensively in the management of envenomed victims. The application of a hair-string or grass-string ligature, suctioning of the bite-site and incision were practised in a variety of combinations. Such evolved independently of and pre-dated such practices, which were promoted extensively by immigrant European doctors in the late 19th century.

Pacific scientific toxinology began in the 17th century with Don Diego de Prado y Tovar's 1606 account of ciguatera. By the end of the 19th century more than 30 papers and books had defined the natural history of Australian elapid poisoning. The medical management of snakebite in Australia was the focus of great controversy from 1860 to 1900. Dogmatic claims of the supposed antidote efficacy of intravenous ammonia by Professor G.B. Halford, and that of strychnine by Dr. Augustus Mueller, claimed mainstream medical attention. This era of potential iatrogenic disaster and dogma was brought to a conclusion by the objective experiments of Joseph Lauterer and Thomas Lane Bancroft in 1890 in Brisbane; and by those of C.J. Martin (from 1893) and Frank Tidswell (from 1898), both of Sydney. The modern era of Australian toxinology developed as a direct consequence of Calmette's discovery, in Paris in 1894, of immune serum, which was protective against snakebite. We review the key contributors and discoveries of toxinology in colonial Australia.

Keywords: Aboriginal medicine; Australia; History of toxinology; Snakebite; Ciguatera

1. Introduction

When European colonists settled in Australia from 1788 they encountered the planet's richest fauna of venomous creatures. The world's most venomous creature, the box jellyfish, *Chironex fleckeri*, the world's most venomous snake, the Western Taipan, *Oxyuranus microlepidotus* and the world's most venomous mammal, the male platypus, are all found in Australia. The medical management of those victims envenomed by snakes, spiders, ticks, poisonous fish and jellyfish featured extensively in the writings of post-Settlement expeditioners, anthropologists and doctors.

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Unbeknown to those European colonists, there existed a prior and detailed knowledge of Australia's venomous creatures. Such knowledge had been transmitted in intergenerational oral form by the Aboriginal Peoples of Australia, perhaps for 40 millennia or longer. Until the Federation of the States of Australia in 1901, Aboriginal knowledge of the biology of venomous creatures was more detailed than that of western science, to which Aboriginal lore was opaque and sometimes secret (Fig. 1). Undoubtedly, field management of the poisoned victim was safer in the context of Aboriginal techniques than in that practised by the colonial doctors who supplanted them (Covacevich, 1990a).

Toxinology, or the study and understanding of biological poisons and their effects on the human body, had evolved as a scientific subject since the days of Aristotle (364–322 BC). European colonists to Australia brought with them prevailing late 18th and early 19th century medical practices to the problem of human envenomation, the most common and dramatic example of which was that caused by venomous snakes; and specifically that caused by snakes of the family Elapidae, or the common front-fanged snakes. Some eight of the 80 Australian species of Elapidae rank as the world's most dangerous snakes.

This paper documents the chronology of the evolution of medical management of envenomed victims, always a feared and dramatic event in the Australian "Outback" and especially so in the era before the first credible venom research began in the last decade of the 19th century. It examines the interface between Aboriginal and European "first aid", although that term was not used in English until 1879 (Pearn, 1994); and traces the development of medical toxinology in Australia until the first suggested trials of antivenom were proposed by Charles (later Sir Charles) James Martin (1866–1955) in Sydney in 1897.

Fig. 1. The Western Taipan, *Oxyuranus microlepidotus*, the world's most dangerous snake. For tens of millennia before European colonisation of Australia, this snake was "Dandarabilla" to the traditional Aboriginal owners of the land between Coopers Creek and the Diamantina River in central parts of Australia. Photograph courtesy of Jeanette Covacevich AM, with acknowledgements.

2. Clinical toxinology—the aboriginal peoples

Aboriginal forbears well knew the dangers of the box jellyfish in northern Australian waters (Cleland and Southcott, 1965). Poisoning by toxic plants was understood in great detail (Pearn, 2001a); and an elaborate and sophisticated system of food taboos was still practised by the world's oldest surviving culture, that of the Kaiadilts of the Gulf of Carpentaria, well into the late 20th century (Pearn and Sweet, 1977).

In 1788, there existed in Australia more than 600 language groups of Aboriginal Peoples. Over the preceding 30–60 millennia many of these tribal groups had developed both an accurate knowledge and deeply held beliefs about the fauna and flora upon which life itself depended. Not all of these beliefs were accurate (Fig. 2). For example, it is now appreciated that the Flying Snake, although greatly feared by several tribal groups on Mornington Island, is in fact the harmless Burton's Legless Lizard, *Lialis burtonis*, and an excellent food source (Covacevich, 1990a). Most Aboriginal knowledge of

Fig. 2. Harmless Burton's Legless Lizard, *Lialis burtonis*, of Mornington Island, the Gulf of Carpentaria. The Lardil and Kaiadilt People of Mornington Island called this reptile the Flying Snake and believed that its bite was rapidly fatal. Photograph courtesy of Jeanette Covacevich AM, with acknowledgements.

the history of toxic fauna and flora was very detailed. It is known, for example, that even in the late 20th century, Yidinjyi women, formerly of the rainforests of the Cairns hinterland, "had an extensive oral *materia medica* derived from a florilegium of some 600 rainforest species—a herbal passed down by oral tradition" (Pearn, 2001a). By contrast, Australian medical practitioners today use at most an individual working pharmacopoeia of no more than 60 drugs.

Men and women of the various Aboriginal language groups assiduously avoided being bitten by snakes (Macpherson, 1902). When snakebite occurred, as in the case of later European victims, it was "always something of a medical *cause célèbre*" (Covacevich, 1990a).

It is a tragedy that no first-person accounts, by Aborigines, of the Aboriginal medical management of victims poisoned by snakes, spiders, ticks or toxic plants have ever been published. The first European writings about the field management of snakebite by the Aboriginal Peoples were first-hand observations by travellers and explorers. One of the first such recorded observations was made by Allan Cunningham (1791–1839) in 1827, prior to his appointment as Colonial Botanist, when he noted that Aboriginal men of the Sydney district would treat a snake-bitten victim by "tying a tight ligature above the part and scarifying and sucking the wound" (Cunningham, 1827). Subsequently, anthropologists described a miscellany of other practices employed to treat the victims of snakebite (Covacevich, 1990b). Such medical management ranged from the use of a pulped *Eucalyptus* poultice applied to the bite site, as in the case of some Queensland tribes (Cunningham, 1827); or emu fat applied to the wound by traditional tribal healers of the Aboriginal Peoples of the Western District of Victoria (Dawson, 1881). Both suction and fumigation—suspending the bitten limb or the entire body of the victim over a smoking fire—were recorded among the practices of the Mitakoodi and Kalkadoons of north-western Queensland (Roth, 1897).

One first-hand account of snakebite management by Aboriginal men of the Boulia district exemplified the comingling of physical practice, of folklore and spiritual belief—an adjunction which was later mirrored by many Europeans in their management of snakebite. A first-hand account of Aboriginal first aid for snakebite was documented by the medical anthropologist and explorer, Dr. Walter Edmund Roth (1861–1933):

> The sufferer would see the creature [the snake] gliding away after it had bitten him, and would carefully watch the hole into which it hides: this he immediately blocks up, and makes a careful note of the exact spot. With his hairbelt or any other convenient twine, he next ties two ligatures around the limb bitten, above and below the knee if on the leg, or above and below the elbow if on the hand 'to stop the blood come up': if possible, he applies suction to the wound. His gin or any other mate who may be present, would rush back to consult the nearest doctor, and returning, dig a largish hole in close proximity to where the accident took place, kindle a fire in it and heat some big stones and lumps of rock: when these have become sufficiently hot and the flames somewhat subsident, a lot of fresh leafy bowers, branches and leaves, sprinkled with water to prevent ignition, are placed on top. Upon this smoking mass of foliage the bitten individual now lies, and what with the smouldering embers and hot steam arising from the leaves, he soon becomes enveloped in perspiration, falls asleep for two or three hours, wakes up refreshed, has a 'spit', and is quite recovered (Roth, 1897).

A review of such pre-European snakebite management practices suggests that there were three essential themes to this evolved wisdom of the ages. Firstly, the miscellany of beliefs and practices were not harmful to the victim; and, unlike later European practices—such as the intravenous injection of ammonia or strychnine—did not complicate or extend the pathology of the envenomation itself. Secondly, there were occasional erroneous beliefs about which species of snakes were venomous; and that many of the medical approaches by Aboriginal healers were essentially supportive and psychological. Fear itself produces signs and symptoms which may mimic the effects of venom, even in patients bitten by non-venomous snakes (Pearn, 2002). Roth recorded one such example. He noted that the Aboriginal healer would care for a snakebite victim by looking

> up at the sky and declare that he could see 'mulkari' spitting, and that therefore the patient would be alright if he went under the prescribed treatment. Furthermore, the [Aboriginal] doctor himself comes to the place where the accident happened, is shown the identical spot where the snake lies imprisoned [in a blocked hole], digs it out and lets it travel away a few feet before

commencing to pelt at it with stones. During this process the snake gradually becomes smaller and smaller until, from an original length of three or four feet, it dwindled down to ten or twelve inches; the creature, thus rendered harmless, is carried back to camp, where the medicine man, turning its skin half-way inside out while still alive, throws it into the water, and so makes an end of it. It is needless to say that no lay-man is allowed to witness the process of causing the ophidian to diminish in size (Roth, 1897).

A third feature of the Aboriginal management of snakebite was that of using local excision, suction or the local application of a medicinal herb or charm to the bite-site. Such practices ranged widely across Australia—from those practised by members of the Dalleburra tribe in Queensland (Bennett, 1927), to similar techniques observed in Arnhem Land and in other regions throughout Australia (Webb, 1969; Anonymous, 1982). Such practices undoubtedly influenced the accepted European first aid management of snakebite victims, until the last decades of the 20th century.

3. Envenomation and first aid in pre-federation Australia

Field management of snakebite victims and the quality of first aid rendered to them was of crucial importance not only for survival, but also for the prevention of iatrogenic harm. The German term "este hilfer" was first used by Friedrich von Esmarch (1823–1908), the Prussian Surgeon General (Pearn, 1994); and in its English translation of "first aid" in 1878 by the Scottish Surgeon-Major Peter Shepherd (1841–1879). Shepherd introduced the concept of first aid, as a series of drills and skills, which might be acquired by every civilian. "First Aid to the Injured", initially published by the St John Ambulance Association in 1879, has been the western world's and Australia's secular best-seller since that time (Pearn, 1998). From the outset, all first aid textbooks and their predecessors, the colonists' and farmers' "Family Medical Guide", gave instructions about the field management of snakebite (Fullerton, 1870).

One such booklet, *The Medical Telephone*, contained "Hints for the Preservation of Health…[and] Ambulance Notes on Wounds and Fractures". It was published in Hobart in 1883. Its first aid advice was:

BITES—if by poisonous snakes or insects [the wound] should immediately be well sucked; for an hour or more if a snake. Then strong ammonia may be applied to the wound; that will relieve the pain of insect bites, and obviate after results (Homoeopathic Pharmacy Hobart, 1883),

The first aid or field management of the envenomed colonist included cautery, suction, excision and application or injection into the bite site of carbolic acid or potassium permanganate (Condy's Crystals), this latter carried for a century by bushmen in the Outback for just this purpose (Figs. 3–5).

Colonial first aid practices for snakebite had evolved from the original teaching of William Harvey (1578–1657), he of "De Motu Cordis et Sanguinis", and one of the pioneers of experimental toxinology. Harvey wrote

…in the bite of serpents…a man might be saved…if a very strong ligature were made above the wound immediately and the mortified part below the ligature were cut off presently (Warrell, 2001).

This exhortation developed into pragmatic if drastic action in the Australian Outback two

Fig. 3. Three first aid kits for snakebite and spiderbite, similar to many types carried and used by Australian colonists, farmers and travellers away from medical aid. Both wooden ends unscrew—one to reveal a lancet, the other hollowed to contain several grams of potassium permanganate (Condy's Crystals). Photograph courtesy of Vincent Little, Deputy Commissioner of St John Ambulance Australia (Qld), with acknowledgements.

Fig. 4. A snakebite first aid kit typical of those used in the colonial and later post-Federation era in Australia. The hollow cap (right) contained crystals of potassium permanganate for rubbing into the lanced bite-site. Photograph courtesy of Vincent Little, Deputy Commissioner of St John Ambulance Australia (Qld), with acknowledgements.

Fig. 5. A Doctor's Snakebite Kit containing a silver tourniquet toggle, lancet, glass vial of potassium permanganate, syringes, needles and suction apparatus. Manufactured by L. Bruck, in Sydney. Photograph courtesy of Vincent Little, Deputy Commissioner of St John Ambulance Australia (Qld), with acknowledgements.

centuries later. Instances are recorded where "the bitten area was cauterised by setting fire and a heap of gunpowder poured on it, or amputation of the bitten part with an axe or gun" (Sutherland, 1994). In other cases, "the victim was heroic enough to bite out the piece [of tissue at the snakebite site]" (Tidswell, 1906). One of the authors is aware of another case, in the 1930s, of a Brisbane victim of a Death Adder bite amputating his finger with an axe.

The formal Australian first aid treatment of snakebite and spider bite in this era may be summarised:

1886: Ligature, incision, suction; rubbing gunpowder into the wound and firing it; washing the mouth out with brandy (Martin, 1886).

1905: Ligature, suction; introduce caustic potash or pure carbolic acid into the bitten area with a pointed piece of wood (Cantlie, 1905 [St. John Ambulance Association]).

4. Scientific toxinology in the 18th and 19th centuries

Naval and military surgeons were the founders of Australian toxinology. Expeditioners all, they gave fragmentary descriptions of new clinical syndromes consequent upon poisoning by venomous creatures or toxic flora.

The first toxinological record in the Pacific region is that to be found in unpublished and hitherto untranslated manuscripts of the 1606 Torres expedition from Peru to Manila, through what is today Torres Strait (Windolf, pers. comm.). These manuscripts were written by Don Diego de Prado y Tovar ["Prado"] (Windolf, 2000) and describes the work of the expeditions two naval doctors in coping with what was undoubtedly ciguatera. One of Cook's surgeons on his second (H.M.S. *Resolution*) voyage in 1786, Surgeon Lieutenant William Anderson RN, wrote the foundation description in English of ciguatera in the Pacific (Pearn, 2001d).

However, to date the earlier formal written records of Australia's venomous creatures come from Sir Joseph Banks FRS (1743–1820). His expedition journal (HMB Endeavour, 1768–1771) represents the foundation document of European Australia. At 25 he joined the voyage of the Endeavour and ended up collecting 30,000 plant and 1000 animal specimens. Banks encountered some venomous creatures en route through the Atlantic and Pacific oceans, particularly jellyfish: "In the Evening [of August 28, 1768] very calm; with the small casting net took several specimens of Medusa Pelagica, who different motions in swimming amus'd us very much…". But it was in Botany Bay that he collected his first venomous Australian, the "bull-dog" ant, *Myrmecia gulosa*. Fortunately,

no stings from these arthropods were recorded until Cook's second expedition.

The first definite envenomations, from the yellow tussock moth, *Porthesia* (now *Euproctis*) *lutea* were documented several months later (May 23, 1770) in Bustard Bay, Queensland; "The mangroves had also another trap which most of us fell into, a small kind of caterpiler, green and beset with many hairs…if these wrathful militia were touched…they did not fail to make the person offending them sensible of their anger, every hair in them stinging as much as nettles do…".

Similarly, despite modern-day preoccupations with snake and spiders, Banks complained most about the arthropods, particularly ants; "Of insects here were but few sorts and among them only the Ants were troublesome to us…one green as a leaf and living upon trees…But industrious as they are their courage if possible excells their industry; if we accidentally shook the branches on which such a nest were hung thousands would immediately throw themselves down, many of which falling upon us made us sensible of their stings and revengefull dispositions…". These creatures, the green tree or weaver ant, *Oecophylla smaragdina,* remain very familiar to those living in the north of Australia.

Although Banks did encounter reptiles, including probable sea snakes, further northward, no bites were recorded. He wrote in August 17, 1770; "As we were now safe at anchor it was resolved to send the boats upon the nearest shoal…In our way we met with two water snakes, one 5 the other 6 feet long; we took them both; they very much resembled Land snakes only their tails were flatted sideways, I suppose for the convenience of swimming". Further venomous arthropods were noted in subsequent Cook expeditions, including reference to what must be the small forest scorpion, *Cercophonius squama*, at Adventure Bay, Tasmania, by the naval surgeon William Anderson in 1777 (Southcott, 1986). Banks also sent specimens of platypus to England that were eventually examined (in 1801) by Mr (later Sir) Everard Home who found "in the male, just at the setting on of the heel, there is a strong crooked spur half an inch long, with a sharp point" (Tidswell, 1906). Sir John Jamieson provided in 1817, one of the first, and most vivid descriptions of the effects of this envenomation by "this wonderful animal" (Tidswell, 1906).

The first doctor in Australia, Surgeon General John White RN (1756–1832), wrote the first formal scientific description of a venomous Australian reptile, the Red-bellied Black Snake, *Pseudechis porphyriacus* (Pearn et al., 2000) then referred to as the "crimson-sided snake" *Coluber porphyriacus* (see Cogger, 1985). Contributions to emerging scientific knowledge of toxic biota followed rapidly due to reports by a succession of British and French naval surgeon-explorers—Robert Brown, Deschamps, Peron, La Billardiere, Gaimard and Bynoe—who brought with them a background of system and a training in biology (Pearn, 1990). They enjoyed the privilege of travel as an inescapable part of their military service; and they had both the opportunity and the time to describe "new" species of poisonous plants and animals. Their contributions to toxinology were often opportunistic and almost never experimental, but were of great value to the corpus of evolving knowledge.

Their writings and reports were one of the stimuli, which led to the commissioning of the greater biological and hydrographic expeditions which were to follow—that of H.M.S. *Fly* (1842–1845), H.M.S. *Rattlesnake* (1845–1849) under Captain Owen Stanley RN and in 1852, the H.M.S. *Herald* expedition under Captain H.M. Denham RN. These expeditions resulted in extensive reports of poisonous fish, medusae and seasnakes. By 1875 (Koch, 1871–1877), seven of the genera of seasnakes in Australian waters had been described, three of which (*Aipysurus, Disteira* and *Acalyptus*) were in Indian Ocean waters (Fayrer, 1874).

The three most significant 19th century biologists to contribute to the understanding of Australian poisonous biota were the herpetologist, Gerard Krefft, the arachnologist, Ludwig Koch and the botanist, Ferdinand von Mueller (1825–1896). Krefft published his first paper on the snakes of the Sydney region in 1865; and in 1869 brought a cohesion and synthesis to the emergent scene of Australian herpetology in his *The Snakes of Australia: an Illustrated and Descriptive Catalogue of All the Known Species* (Krefft, 1865, 1869). This datum work was followed by two census lists of Australia's snakes including venomous species (Macleay, 1884; Waite, 1898). In similar fashion, Koch published *Arachnids of Australia* over 7 years from 1871. This work established the formal taxonomic infrastructure on which the later foundations of arachnid medical work by Tidswell, Cleland, Ross, Southcott, Domrow, Sutherland, Pearn, Raven, Winkel and Isbister were to be laid.

An important medium for the public education about venomous creatures was that of the private

natural history "museum", several of which were to be found in various Australian cities from the mid-19th century. A number of collectors, naturalists and doctors, often of unusual personalities, developed such collections particularly in Sydney, Melbourne and Brisbane. These medical naturalists gave public lectures often highlighting in dramatic form the dangers of snakes and other venomous creatures, as a source of income. One was the tormented and volatile Johann Lhotsky (1800-c.1861), self-described as "a man without fortune or connected with government", who established a personal museum at his home in Elizabeth Street, Sydney. He sold specimens and minerals, curiosities of natural history, bones, stuffed birds, snakes and shells. He maintained himself between expeditions and collecting trips by giving public lectures. He was ahead of his time in that he gave lectures informally, and did not read from a prepared text, a practice which his audience regarded as insulting (Pearn, 1990). Another who maintained such a collection, gave public lectures and sold specimens of snakes and other venomous creatures was the former medical student, John MacGillivray (1822–1867), who did so for 2 years from 1864 in Grafton.

Many medical men and amateur naturalists kept venomous snakes for private interest and low-level research. One case (Case III) of Professor Halford's in his review of *The Time Between the Bite [of Australian snakes] and Death*, described a report from Dr. Weir Mitchell—"a dog was accidentally dropped into my snake-box. He was bitten in a dozen places by as many snakes, and perished in about 18 min" (Halford, 1894).

5. Medicine and venomous creatures

One of the ambassadors between the world of natural science and that of clinical medicine was Dr. George Bennett (1804–1893) of Sydney. A young surgeon from Devon, Bennett had sailed as the ship's surgeon on the *Brothers* with Captain Towns for 3 years from 1828. He stayed at Parramatta, "a pretty village situated in a vale". In 1834, he published his *Wanderings in New South Wales, Batavia, Pedir Coast, Singapore and China : being the Journal of a Naturalist in these Countries during 1821–1833 and 1834*. In this work, he described his extensive anthropological, botanical and medical observations. In 1832, Bennett emigrated permanently to Sydney where his name appeared extensively in the *New South Wales Medical Gazette* (Pearn, 1990) (Fig. 6). In 1863, he wrote the *Snakes of New South Wales* published in the *Medico-Chirurgical Review of London,* and contributed to the scientific description of the platypus including the venom spur of the male. He was the first in a great succession of scientists who tried to domesticate and breed the platypus, "a feat only achieved in the 1940s by David Fleay" (Pearn, 1990).

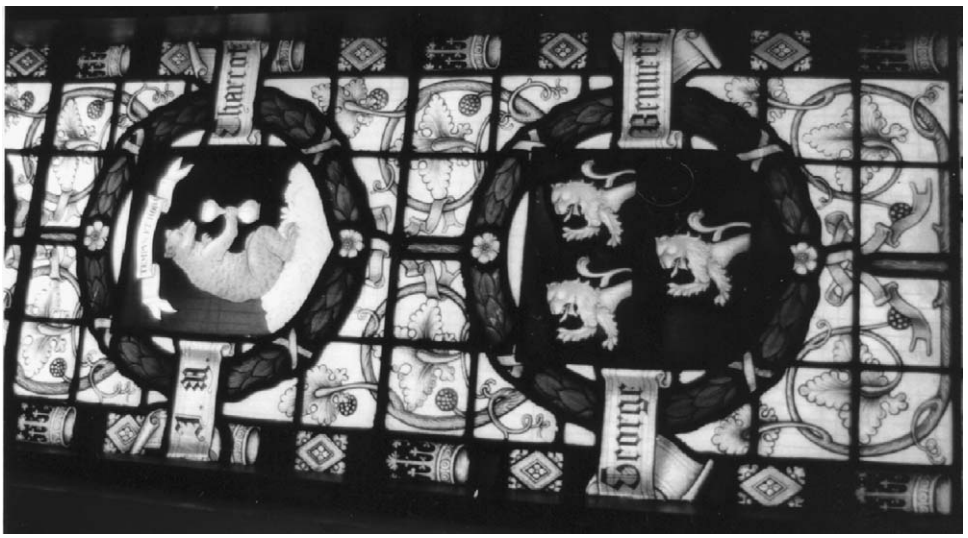

Fig. 6. Bennett Stained Glass Window in the Anderson Stuart Building, the former Faculty of Medicine, University of Sydney. It commemorates the life and work of Dr. George Bennett (1804–1893) surgeon, explorer and biologist, who wrote extensively about Australia's venomous creatures. Bennett described the venom spur of the male platypus. Photograph by the author, 1987.

The second half of the 19th century saw the publication of more than 30 papers and booklets on human snakebite in Australia. These included writings by Clutterbuck (1864), Joseph Bancroft (1866), Berncastle (1869), Report of the Sub-Committee of the Medical Society of Victoria on experiments in snake-poisoning (1870), Halford (1869, 1870, 1894), Creed (1884), Macleay (1884), Mueller (1890, 1893), Rendle (1892), Huxtable (1893), Martin (1895, 1896, 1897a, b) and Thomas Lane Bancroft (1894).

Two of the earliest medical pioneers of Australian 19th century toxinology were Dr. Joseph Bancroft (1836–1894) and his son, Thomas Lane Bancroft (1860–1933), of Brisbane. Joseph Bancroft's publication, in Brisbane, of *Poisonous Animals*, is another publishing datum in the history of toxinology in Australia. Joseph Bancroft was the first to describe tick paralysis due to the Australian scrub tick, *Ixodes holocyclus*. He described poisonous flora and was the first to describe in detail the endurance-enhancing and mydriatic properties of *Duboisia*, the "pituri" of the Aboriginal Peoples (Cribb et al., 1991). Joseph Bancroft's experimental studies of the toxic and pharmacological properties of *Duboisia* and his opportunistic study of envenomed animals and humans were the result of "a prepared mind" which was the characteristic of the Bancroft family (Williams, 1991). Whereas Joseph Bancroft (1836–1894) was a dominant extrovert, it was his quiet and meticulous son, Thomas Lane Bancroft (1860–1933), who made towering contributions to Australian herpetology, botany and parasitology; and who brought some objectivity to the medical management of snakebite in Australia in the last decades of the 19th century (Pearn, 1991).

The last 4 decades of the 19th century saw a series of well-meaning but dogmatic and very dangerous developments in the professed best medical management of snakebite:

1857	Professor Halford's ammonia therapy.
1864	Dr. Agnew's whisky therapy.
1864	Dr. Clutterbuck's new "mercury treatment".
1889	Dr. Augustus Mueller's strychnine therapy.
1890–1900	The scientific era of venom research began. Experiments by Joseph Lauterer and Thomas Lane Bancroft in Brisbane; and Charles Martin and Frank Tidswell in Sydney.

Professor George Britton Halford (1824–1910) was the foundation Professor of Anatomy, Physiology and Pathology (from 1862) at the newly established University of Melbourne Medical School (Osborne, 1929)(see Fig. 7). Halford was a dedicated comparative anatomist. He was particularly interested in the relationship of the blood flow in the hearts of various animals and the cardiac sounds that emanated there from, including those of the python (Pearn, 2001b).

Halford developed what amounted to a fixed delusion—that the injection of intravenous ammonia was a universal antidote for snakebite (Halford, 1857, 1867, 1869, 1870; Osborne, 1929; Pearn, 2001b). This view became increasingly derided in the medical press. The *Lancet* of 1871 wrote:

> Professor Halford… urges… the duty of injecting even larger doses of ammonia… we adhere,

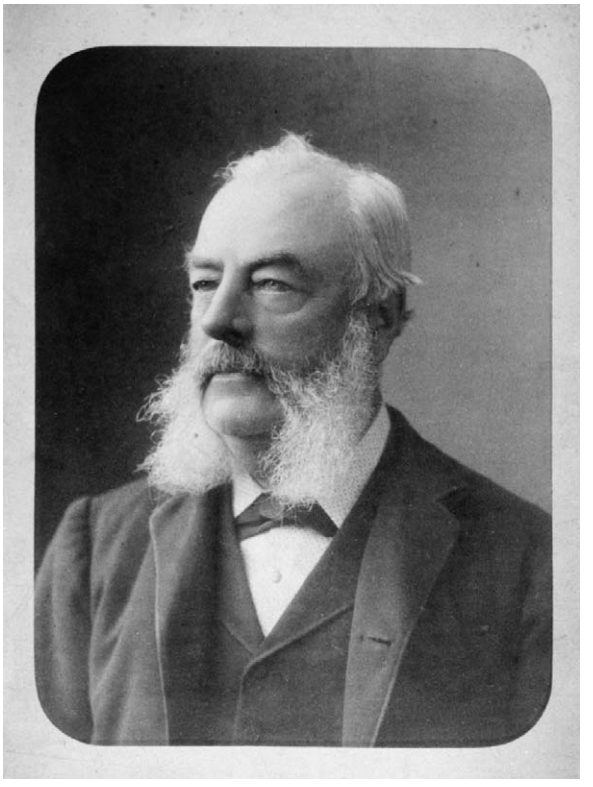

Fig. 7. George Britton Halford, (1824–1910), Foundation Professor of Anatomy, Physiology and Pathology and first Dean of Medicine at the University of Melbourne. He was a controversial figure in the history of Australian toxinology due to his 'germ theory' of snakebite poisoning and his persistent promotion of intravenous ammonia for the treatment of snakebite. He also vigorously opposed the teaching of Darwinian evolution. Photograph courtesy University of Melbourne Archives.

> however, that Professor Halford's induction is not so scientifically complete as to warrant implicit confidence in his practice… (Editorial, *Lancet*, 1871).

Halford held to his beliefs until overwhelming evidence (Report on the effects of artificial respiration, 1874) and the odium of his scientific peers finally forced him to retract, in 1894. Nevertheless, Halford did much good. He fought, decades before its time—for the admission of women to the Faculty of Medicine—and in other scientific contexts was regarded as "a most distinguished experimental physiologist" (Pearn, 2001b). Unfortunately, his "ammonia cure" for snakebite permanently damaged his reputation (Editor, Lancet, 1864, 1870, 1871, 1980) (Fig. 7).

Like the "ammonia cure" controversy, Dr. Augustus Mueller's "strychnine cure" also became a major controversy from the latter's first claims from his home at Yackandandah in 1889. Mueller's strychnine cure held sway for 5 years, culminating in his book *On Snake Poison. Its actions and its antidote* (Mueller, 1893). Typical of the dogma of many new medical "discoveries" of that and later decades, Mueller was joined by powerful friends, no less than the editor of the *Australasian Medical Gazette* who opined "that no medical man in Australia now can treat a case of snake-bite other than by his method [Mueller's intravenous injection of strychnine] without incurring the charge of culpable ignorance" (Editor, 1890, *Australas Med Gaz*).

This potential iatrogenic disaster was counteracted by independent meticulous experiments by two Brisbane toxicological pioneers, Thomas Lane Bancroft in 1890 using rabbits; and by Joseph Lauterer also in 1890 using pigeons. Bancroft's results were published in his paper entitled *Strychnine, a useless remedy in snake-bite* (Bancroft, 1890). The editor of the *Australasian Medical Gazette* riposted with:

> Dr T.L. Bancroft, with that self-satisfied infallibility so characteristic of the young practitioner [Bancroft was 30 years of age at the time], on the strength of a few experiments on guinea pigs, has contradicted the direct and positive evidence in its favour of Dr Mueller, Garde, Bowe, Thwaites, St George, Queely, and others" (Editor, 1890, *Australas Med Gaz*).

Dr. Joseph Lauterer (1848–1911), born in Freiburg in Baden, followed in the tradition of the Bancrofts in Brisbane. He had immigrated to Australia (to the Blue Mountains) in 1885, and subsequently to Brisbane. He brought an enquiring mind and a vigorous scientific discipline to his studies of native plants and animals. His toxinological contributions resulted from a fusion of his experiments in phytochemistry, and his studies in entomology and botany combined with his interest in and study of Aboriginal languages. In the history of toxinology in 19th century Australia, Lauterer's significance ranks third only after that of the Bancrofts (Pearn, 1990) and C.J. Martin. Lauterer also described the scorpion, *Charon annulipes*, "a highly interesting animal possessed of legs which are quite without apparel in the whole class of *arachinidae*" (Pearn, 2001c).

Lauterer was the first medical scientist in Australia to have undertaken experimental studies of the pathogenesis of snake venom neurotoxicity. In the Black Forest (Germany) *Circa* 1875, he had observed the close similarity of the pathophysiological effects of *Viper berus* venom to that of curare, the South American arrow poison from *Strychnos toxifera* (Lauterer, 1890). Bancroft's and Lauterer's work was followed by the experimental studies of Charles (later Sir Charles) James Martin (1866–1955) in Sydney. (Martin, 1893, 1895, 1896, 1897a, b). Martin worked with two other esteemed biologists, J.P. Hill and (Sir) Grafton Elliot Smith, all based at the University of Sydney, and who called themselves "the Fraternity of Duckmaloi". Martin undertook the first fractionation of the poisonous constituents of the Australian Black Snake, *P. porphyriacus*. Following filtration and an attempt to separate "venom colloids from crystalloids", Martin undertook the first fractionation experiments the results of which were published in 1896.

6. Spider envenomation

Although snakebite envenomation was a dramatic event in pre-Federation Australia, spider bites numerically cause greater problems, as they continue to do today. The first report of envenomation by the Australian Red-back Spider, *Lactrodectus hasseltii*, occurred putatively in 1849 (Raven, pers. comm.). The classic features of this important envenomation were definitely evident in an 1863 report; "The first case…was that of a man…at six o'clock a.m., while sitting in a water closet felt himself stung in the lower part of the scrotum. He

complained of a tingling sensation for some time after,…He still deferred calling in medical assistance till twelve o'clock at noon…I found him in great agony" (Carr, 1863). It was shortly thereafter, in 1870, that the first scientific description of the Australian Red-back Spider was made by Teodor Thorell in his *Descriptions of New Spiders of New Holland* (Thorell, 1870). Interestingly, uncertainty remained about the toxic potential of this spider into the early 20th century (discussed in Sutherland and Tibballs, 2001).

The Sydney Funnel-web Spider, *Atrax robustus*, was not described as a new species until 90 years after colonial settlement had been established in Sydney. This feared spider was first described by Octavius Pickard-Cambridge in 1877 (Pickard-Cambridge, 1877). It was to be another 5 decades before the pathognomonic syndrome of overwhelming sympathetic hyperstimulation was described in humans (Cleland, 1932; Ingram and Musgrave, 1933). The first definitive work on the taxonomy of Australian spiders was the result of the often unacknowledged work of the Siebenlehn-born naturalist, Konkordia Amalie Dietrich (1821–1891), collecting in Australia (1863–1873) for the Godefroy Museum (I.C. Godefroy and Son) in Hamburg. Amalie Dietrich's and other's specimens were classified by the German arachnologist, Ludwig Koch, who between 1871 and 1877 named and classified more than 800 species new to science (Koch, 1871–1877). One hundred years later, the human envenomation syndromes of many Australian species remain undefined and often controversial (Isbister and Gray, 2003).

7. Conclusion

The tumultuous period (1860–1895) of clinical delusion, dogma and debate about the management of snakebite in Australia, came to an end with the experimental objectivity of Joseph Lauterer and Thomas Lane Bancroft in Brisbane, and that of C.J. Martin and Frank Tidswell in Sydney. Their studies of snake venom and its actions and their objective analysis of antidote claims were overtaken by Calmette's discovery in 1894 of "the properties of serum of animals immunised against the venom of serpents" (Calmette, 1894). This discovery, and Martin (1897a, b) and Tidswell's (1898–1906) demonstration of the immunospecificity of Australian snake venoms, ushered in the modern era of Australian toxinology.

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