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Common leaf spot of lucerne and the dawn of mycology and plant pathology in Australia

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ABSTRACT

As the number of livestock increased in the years following English colonisation of Australia in 1788, the need for nutritious fodder, including lucerne (*Medicago sativa*), grew. One of the first diseases found on lucerne was a leaf spot which was collected in 1879 by George Bancroft, a physician and naturalist, in a suburb of Brisbane. The Queensland Government Botanist Frederick Manson Bailey sent a specimen to the prominent English mycologists Miles Joseph Berkeley and Christopher Edmund Broome who in 1883 formally described and named the fungus *Sphaerella destructiva*. That fungus is now known as *Pseudopeziza medicaginis*, the causal agent of common leaf spot of lucerne. It was one of over 300 fungi that were included in a 1880 paper co-written by the Reverend Julian Tenison-Woods and Frederick Bailey. At that time almost all of these fungi which had been collected in Australia were identified by overseas mycologists, particularly Berkeley and Broome. It can be argued that their 1880 paper was the first significant one published in Australia which focussed on fungi. Just a decade or so later Australian scientists, in particular Daniel McAlpine, were describing new fungal taxa on their own.

Keywords: alfalfa, common leaf spot, Frederick Manson Bailey, lucerne, *Medicago sativa*, *Pseudopeziza medicaginis*, Reverend Edmund Tenison-Woods, *Sphaerella destructiva*.

Introduction

It has been written that there were three stages in the evolution of natural history studies in Australia, namely (i) specimens were collected in Australia during voyages of exploration and returned to Europe where they were studied and identified by non-Australian experts, (ii) specimens were collected in Australia by locals and sent overseas for identification and classification, and (iii) all of these activities were conducted by Australians.[1]

Arguably, the first mycological paper of significance written by Australian scientists can be considered to be that of the Rev. Julian Edmund Tenison-Woods (1832–1889) and Frederick Manson Bailey (1827–1915) in 1880 which included the names (most with short descriptions) of over 300 fungi, including plant pathogens, collected in Queensland and New South Wales.[2] In their Introduction they wrote that up until then studies on mosses, lichens and fungi had largely been ignored in Australia, which they hoped to rectify and attempt to 'popularise the subject (mycology) with a view to stimulate enquiry'. With respect to the 'blights, mildews, rusts, smuts, etc.' they noted that little or nothing was known at the time about the origin and spread of these terrible pests.[3]

One of the fungi they listed was *Sphaerella destructiva* which was described as 'a black or brown spot-like fungus, very destructive to lucerne on the Brisbane River'.[4] There is little doubt that they were referring to the disease common leaf spot, now known to be caused by the fungus *Pseudopeziza medicaginis*. In this paper I provide a brief outline of

[1] King (2016) p. 50.
[2] Tenison-Woods and Bailey (1880).
[3] Tenison-Woods and Bailey (1880) p. 57.
[4] Tenison-Woods and Bailey (1880) p. 91.

lucerne in the early days of English colonisation, discuss some aspects of the identity of the common leaf spot pathogen and finally present short biographies of the Reverend Julian Tenison-Woods and Frederick Manson Bailey. Information was sourced from readily available on-line resources, books, and paper versions of articles, and other sources.

Lucerne in the early days of the New South Wales colony

It is not known when the first seed of lucerne (*Medicago sativa*, also known as alfalfa) was brought into the colony of New South Wales. Lucerne seed was not in the list of provisions, and materials brought to the colony on the first fleet in 1788.[5] The first known mention of the legume in the colony was in Governor Philip Gidley King's (1758–1808) list of non-indigenous plants in the colony which he had sent to Sir Joseph Banks (1743–1820) in 1803, fifteen years after the first fleet landed at Sydney Cove. 'Lucern' is listed under the heading 'Grass seeds' and was 'scarce', but no varieties are mentioned.[6] The exact source of the seed is unknown, but some believe that the earliest seed was most likely from France, which was the major lucerne seed producer at the time.[7] However, there were other sources because English lucerne seed was being advertised for sale in Sydney in 1827.[8]

A few years later, Governor King wrote that although some crops of lucerne yielded three cuts per year, few cultivated it because the crop required a lot of care and attention, and direct grazing by livestock was not desirable.[9] Also, it had been stated that farmers had not found a need for 'artificial food' because the woods (open forest) had yielded sufficient quantities of feed for their livestock and that 500 head of cattle could be grazed in forests for an outlay of £160.[10] The author did suggest that artificial grasses (including lucerne) could be sown on the banks of creeks and rivers to improve productivity.[11]

The first mention of lucerne in an Australian newspaper was a classified advertisement in 1815 offering seeds, including those of lucerne, for sale.[12] However, only a few 'patches' of lucerne were being grown in the colony at the time.[13] The settler James Atkinson (1795–1834), who farmed for a time in New South Wales, commented that lucerne had been tried with great success, but 'no attempts had been made toward feeding livestock with artificial food'.[14]

Despite this, lucerne hay was apparently a valuable commodity worthy of stealing because 'Cultivator', a farmer on the Hawkesbury River, complained that some people had been cutting and removing patches of lucerne, herbage, barley and oats from his farm under the cover of darkness. He/she also noted that the practice of stealing forage had not been an issue in the past, presumably because lucerne and herbage had not been cut for hay, but with the improved state of cultivation it was becoming common.[15]

Lucerne seed was also being produced and sold around this time because J. Oxley supplied 93 lb (42 kg) of lucerne seed as well as seed of 'grass', rye and clover to the colonial authorities at Emu Plains in 1825.[16] Lucerne hay must have become more common as the numbers of livestock increased in the late 1820s, as reflected in an advertisement by Mr Howes of Glenlee who offered 1st class hay for £8/ton and 2nd class hay for £6/ton.[17] By the following year, lucerne hay was being sold at the Sydney Markets.[18]

In 1800, the numbers of livestock owned by the crown on the Australian continent was estimated to be 6124 sheep, 1044 cattle, and 203 horses,[19] and in 1850 there were about 16 million sheep, 1.9 million cattle and 160 000 horses.[20] The increase in livestock numbers over the next fifty years was dramatic, with over 70 million sheep, 8.6 million cattle and 2.6 million horses being recorded in 1900.[21] The key drivers of this increase included the granting of grazing rights and land tenures, an expanded railway system, access to capital from banks, and other factors.[22]

Consequently, the need for 'artificial feed' for livestock also increased dramatically. Data for hay production are

[5] Anonymous (2023*a*).
[6] King (1803).
[7] Nichols and others (2012) p. 695.
[8] Bunn (1827).
[9] King (1898) p. 158.
[10] Anonymous (1898) pp. 177–178.
[11] Anonymous (1898) p. 178.
[12] Anonymous (1815).
[13] Anonymous (1817).
[14] Atkinson (1826) p. 45.
[15] "Cultivator" (1824).
[16] Anonymous (1825).
[17] Howes (1830).
[18] Anonymous (1831).
[19] Anonymous (1896) p. 118.
[20] Anonymous (1908*a*) p. 278.
[21] Anonymous (1908*a*) p. 279.
[22] Nichols and others (2012) p. 694.

available only from 1860 inwards, when over 232 000 acres (94 000 ha) was grown in Australia, which increased to over 1.5 million acres (607 000 ha) in 1900.[23] Data for the area under lucerne are available from 1900 onwards, when over 115 000 acres (47 000 ha) were grown in Queensland (Qld) and New South Wales (NSW).[24]

The Hunter River valley of the central coast of NSW became the most important seed-producing region by the 1850s, from which the variety 'Hunter River' emanated at about the same time.[25] It was a very erect, adaptable variety whose attributes included early growth in Spring lasting until late Autumn, rapid response to water and quick recovery after cutting.[26] It remained the dominant lucerne variety in Australia until the mid-1970s when its susceptibility to phytophthora root rot (caused by *Phytophthora medicaginis*) and crown rot (caused by *Colletotrichum trifolii*) began to impact severely on productivity.[27] It was believed that 'Hunter River' was derived from random crosses between smooth Peruvian and Arabian lucerne lines and perhaps common American lucernes, followed by natural selection.[28] Apparently, acclimatised seed (Hunter River) produced lucerne stands that were superior to those grown from seed sourced from the USA, England and Hungary.[29]

Pseudopeziza medicaginis, the common leaf spot pathogen of lucerne

There is confusion over the nomenclature of the fungus that causes common leaf spot of lucerne. The accepted name is *Pseudopeziza medicaginis* (*Ps. medicaginis*),[30] whose basionym (the original name) is *Phacidium medicaginis*. That latter fungus was described in 1832 by Libert,[31] and its synonyms are *Phyllachora medicaginis* which was named by the Italian mycologist Pier Andrea Saccardo (1845–1920)[32] and *Ps. trifolii* f.sp. *medicaginis* erected by the German Heinrich Simon Ludwig Friedrich Felix von Rehm (1828–1916).[33] The name *Pseudopeziza medicaginis* was erected by Saccardo in 1887.[34]

Common leaf spot is characterised by distinctive dark, circular spots, 1.5–3 mm in diameter on young stems and mostly the adaxial surface of leaves. In the centre of each spot is an erumpent apothecium[35] 1–1.5 mm in diam. whose upper surface is lined with a palisade of asci 60–70 μm long separated by long paraphyses.[36] Each ascus contains eight aseptate ascospores 8–12 μm long.[37] Saccardo described *Ps. medicaginis* as possessing asci 75–80 μm long separated by filiform-clavate paraphyses, each ascus containing eight ovate, aseptate, bi-guttulate ascospores 8–11 × 4–6 μm.[38]

The confusion of names for the common leaf spot pathogen in Australia

In early Australian literature confusion about the names and/or identities of the fungi found in the spots (lesions) typical of common leaf spot is evident. Tenison-Woods and Bailey called the fungus associated with dark leaf spots on lucerne *Sphaerella destructiva* (*Sp. destructiva*).[39] That name was not formally erected until two years later by the English mycologists Miles Joseph Berkeley (1803–89) and Christopher Edmund Broome (1812–86) from a specimen sent to them by F. M. Bailey from Brisbane.[40] It can assumed that the English mycologists had written to Bailey in 1881 or before that they were intending to name the fungus *Sp. destructiva*. Berkeley and Broome noted that minute 'perithecia'[41] developed in brown spots, in which short (0.003″ long; 76 μm) asci developed and in which subelliptical, aseptate (asco)spores 0.0005″ (13 μm) long developed.[42] They did not name the host, but it is extremely likely that it was lucerne, based on Tenison-Woods and Bailey's paper. This description is at odds with the one provided by Tenison-Woods and Bailey in 1880 who

[23] Anonymous (1908*b*).
[24] Anonymous (1908*b*).
[25] Nichols and others (2012) p. 695.
[26] Spafford (1931) p. 8.
[27] Nichols and others (2012) p. 702.
[28] Spafford (1931) p. 8.
[29] Mussen (1900) p. 858.
[30] Samac and others (2014).
[31] Anonymous (2022).
[32] Saccardo (1873).
[33] Rehm (1896) p. 598.
[34] Saccardo (1887) p. 455.
[35] An apothecium of an ascomycete fungus is a cup-like or saucer-like structure on which asci develop.
[36] Asci are sac-like structures in which ascospores develop, and paraphyses are sterile hyphal elements which develop between asci.
[37] Jones (1919) pp. 3, 7.
[38] Saccardo (1889) p. 724.
[39] Tenison-Woods and Bailey (1880).
[40] Bailey (1896) p. 32.
[41] At the time of Berkeley and Broome the structure now known as an apothecium was called a 'perithecium', but now the term perithecium describes a flask- or globose-shaped structure in which asci develop.
[42] Berkeley and Broome (1883) p. 71.

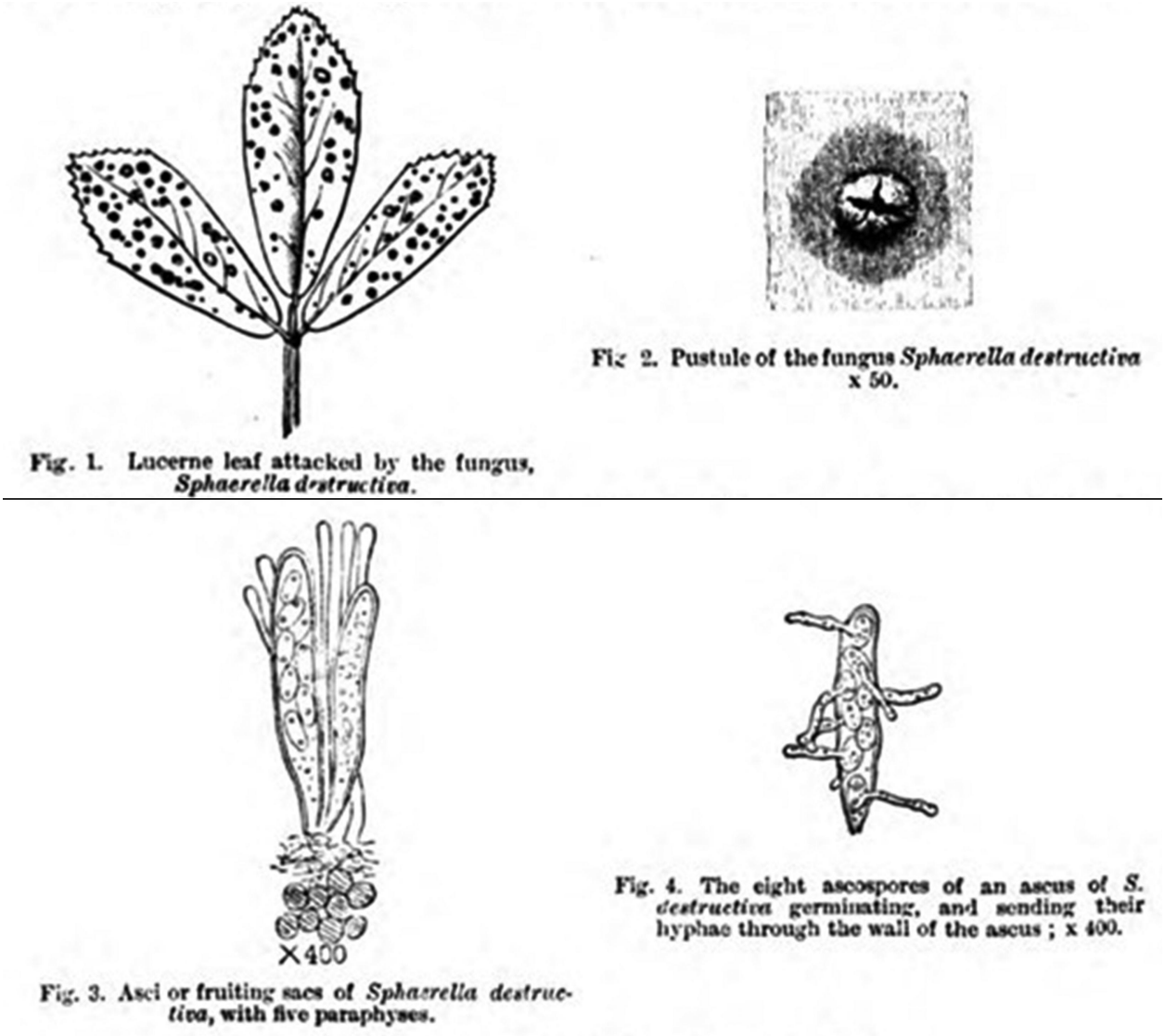

Fig. 1. Illustrations of *Sphaerella destructiva*, Cobb (1892), pp. 107–108, https://babel.hathitrust.org/cgi/pt?id=uiug.30112112405409&view=1up&seq=193 and https://babel.hathitrust.org/cgi/pt?id=uiug.30112112405409&view=1up&seq=194.

described the ascospores as being oblong, pale hyaline-coloured, and two or more-celled.[43]

In 1886, Saccardo transferred *Sp. destructiva* to *Laestadia* with an identical description to that provided by Berkeley and Broome (1883), and again the host was not mentioned.[44] However, The New South Wales Vegetable Pathologist Nathan Cobb (1859–1932) wrote that in parts of New South Wales, the very destructive *Sphaerella destructiva* (as written) caused round 'pustules' on all parts of lucerne plants, but mostly on the leaves which, when covered with many of the structures, became discoloured.[45] He also noted that a single 'perithecium' developed in the centre of the dark spot in which there were asci, 70 × 10 μm containing eight ellipsoidal ascospores, 9–10 × 4–5 μm (Fig. 1).[46] He recommended that growers ensure good (ground) surface drainage as well as cutting frequently (at least every 3–4 weeks) and removing the hay as soon as possible.[47]

Six years later the English mycologist Mordecai Cubit Cooke (1825–1914) in his *Handbook of Australian Fungi* used Saccardo's 1883 binomial, listing *S. destructiva* as a

[43]Tenison-Woods and Bailey (1880).
[44]Saccardo (1886) p. 62.
[45]Cobb (1892) p. 107.
[46]Cobb (1892) p. 107.
[47]Cobb (1892) p. 108.

synonym of *Laestadia destructiva*.[48] His description was identical to that of Berkeley and Broome (1883) and included the term 'perithecium' in reference to the fruiting bodies of the fungus. His figure no. 233 showed that the ascospores were aseptate.[49] Bailey wrote that Dr Joseph Bancroft (1836–94), a medical practitioner, naturalist and amateur plant pathologist, had collected the fungus (which he believed to be *Laestadia destructiva*, and whose synonym was *Sp. destructiva*) on lucerne at Kelvin Grove (a suburb of Brisbane about 2 km from the river) in 1879.[50]

The Victorian Vegetable Pathologist Daniel McAlpine (1849–1932) believed that the two names had been associated with the common leaf spot, *Laestadia destructiva* and *Pseudopeziza medicaginis* were of distinct species. At that time McAlpine recorded that the former occurred in New South Wales, Queensland and Victoria[51] and the latter only in Victoria.[52] He placed *L. destructiva* in the Order Foliicolaceae of the Group Pyrenomycetes (as written),[53] describing it as having minute receptacles raised above the 'general surface' in brown spots, while *P. medicaginis* was in the Order Phacidiceae of the Group Discomycetes (as written), with minute, flattened, ochre brown disc or cup-shaped apothecia in yellow spots.[54]

Bailey also used the binomial *Laestadia destructiva* and did not mention *Ps. medicaginis*, noting that the disease associated with *L. destructiva* was very common on badly-cultivated lucerne.[55] Although Tenison-Woods and Bailey (1880) and Cobb (1892) reported that there were paraphyses in the asci of the fungus,[56] neither Cooke (1892) nor Bailey (1896) mentioned them.[57]

The Queensland plant pathologist John Howard (Jack) Simmonds Jnr (1901–92) believed that *Laestadia destructiva* and *Pseudopeziza medicaginis* were one and the same fungus.[58] Under the heading '*Pseudopeziza medicaginis*—leaf spot', he wrote that it had been called *Laestadia destructiva* and *Sphaerella destructiva*, and mentioned Bailey's 1896 observation that it was 'very destructive on lucerne on the Brisbane river'. However, both Index Fungorum (www.indexfungorum.org). and MycoBank (www.mycobank.org) currently recognise *L. destructiva* as a valid taxon, with *S. destructiva* as its synonym. However, neither name is listed as being a common pathogen of lucerne (alfalfa).[59]

Pseudopeziza medicaginis has been recorded in every Australian state—in Queensland in 1879, New South Wales (1891), Victoria (1892), Tasmania (1895) and Western Australia (1912).[60] The pathogen was recorded on lucerne in South Australia (specimen ADW 251) on an unknown date.[61]

Possible reasons for the confusion of names

There are several possibilities for the confusion that had arisen in Australia regarding the fungi associated with common leaf spot of lucerne. Firstly that *L. destructiva* is in fact a synonym of *Ps. medicaginis*, as suggested by Simmonds.[62] However, *Laestadia* is currently placed within the order Diaporthales, family Gnomoniaceae whose members mainly occur as saprophytes on overwintered leaves of trees and are characterised by the production of perithecia-like structures.[63] In contrast *Pseudopeziza* is in order Heliotales, family Drepanopezizaceae, whose members are plant pathogens which form sessile apothecia.[64] The second possibility is that Berkeley and Broome (1883) and Cobb[65] actually saw the reproductive structures of *Ps. medicaginis*, but called the fungus *Sphaerella destructiva*.

Another possibility is that the name *L. destructiva* is valid, and that this organism saprophytically colonises the lesions caused by *Ps. medicaginis*. Evidence for this possibility is that in New York state, USA another species of *Laestadia*, *L. insidiosa* was reported to be saprophytic on lucerne leaves.[66] The fact that *L. destructiva* has never been proven to be a pathogen of lucerne by the fulfillment of Koch's postulates provides support for the saprophyte theory.

It is highly likely that the uncertainty surrounding this subject will ever be resolved, due primarily to the lack of herbarium specimens of *L. destructiva*. For example, despite

[48]Cooke (1892) p. 310.
[49]Cooke (1892) plate 25.
[50]Bailey (1896) p. 32.
[51]McAlpine (1895) p. 127.
[52]McAlpine (1895) p. 147.
[53]McAlpine (1895) p. 126.
[54]McAlpine (1895) p. 146.
[55]Bailey (1896) p. 32.
[56]Tenison-Woods and Bailey (1880). Cobb (1892).
[57]Cooke (1892). Bailey (1896).
[58]Simmonds (1966) p. 46.
[59]Samac and others (2014).
[60]Noble and others (1935) p. 26. Clarke (1980) p. 21. Samson and Walker (1982) p. 36. Shivas (1989) p. 25.
[61]Cook and Dubé (1989).
[62]Simmonds (1966).
[63]Rossman and others (2007) p. 1.
[64]Johnston and others (2019) p. 16
[65]Berkeley and Broome (1883). Cobb (1892).
[66]Stewart and others (1908) p. 408.

the fact that common leaf spot is a relatively common disease of lucerne in Queensland, there are no specimens of *Ps. medicaginis*, *L. destructiva* or *Sphaerella destructiva* in the Queensland Department of Agriculture and Fisheries plant pathology herbarium (BRIP).

Fortunately, in the United States National Fungus Collections (https://nt.ars-grin.gov/fungaldatabases/) there are 356 specimens of *Ps. medicaginis* collected on over twenty hosts (mostly *Medicago* species) from several countries.[67] In the Queensland (Botanical) Herbarium there is a single specimen of *Sphaerella destructiva* (BRI 798911) which was collected by 'Bailey from Brisbane (Australia) on *Medicago* sp.' on an unknown date. This specimen could therefore be regarded as authentic, based on the collector and place of collection. There were no records of *Laestadia destructiva* in the US Fungal Collection.

If high quality DNA can be extracted from this single specimen of *S. destructiva* that was collected over a hundred years ago and now deposited in BRI, as well as from some other specimens of *Ps. medicaginis*, the taxonomic status of the former and its relationship (if any) with *Ps. medicaginis* could be determined with accuracy.

Fig. 2. Reverend Julian Edmund Tenison-Woods, 1880, photographer H. H. Baily, State Library of New South Wales, https://collection.sl.nsw.gov.au/record/nmQddjBn#viewer.

The dawn of mycology and plant pathology in Australia

The Reverend Julian Edmund Tenison-Woods

Julian Edmund Tenison-Woods (Fig. 2) was born Julian Edmund Woods in London in 1832, joining the Catholic Church in 1846 and moving to Tasmania due to ill-health in 1855. He was ordained a year later in Adelaide and given a 22 000 mile^2 (57 000 km^2) parish centred around Penola in south-eastern South Australia. In the following decade he changed his surname to Tenison-Woods, combining his surname with that of his mother's maiden surname.[68] During that decade he published a book on aspects the geology of South Australia and contributed to the *Flora Australiensis*. In 1866 he and Mary Mackillop founded the Sisters of St Joseph of the Sacred Heart which was dedicated to the education of the Catholic poor and others in need.[69] In that year he was appointed the first Director of Catholic Education in Australia.[70]

While Tenison-Woods was residing in Sydney in 1871, disagreements between Bishop Sheil and the Sisters of St Joseph in Adelaide led to the temporary disbanding of the Order. When Tenison-Woods attempted to travel from Sydney to Adelaide to alleviate the situation he was forbidden by the church heirarchy to leave Sydney. He never returned to Adelaide but spent the next 12 years conducting Christian missions and retreats in several Australian states.[71] Apparently, he was a very popular preacher, because a newspaper article in 1880 stated that 'Immense crowds of many denominations' had attended his mission.[72]

Ultimately, in 1883 he was banned from conducting any official church services, so he left the Catholic Church and focussed on his scientific endeavours. According to a newspaper article written forty years after his death, he was described as 'wanting in tact and diplomacy',[73] that probably contributed to his stoush with the Catholic Church. Alternatively, perhaps he just said what he thought.

Tenison-Woods was passionate about natural history, ultimately becoming a member or fellow of many scientific societies including The Royal Societies of New South Wales, Queensland, Victoria, Tasmania and South Australia.[74] In 1879 and 1880 he was elected President of The Linnaean Society of New South Wales and was the vice-president of that Society from 1881 until his death in 1889.[75]

[67] Farr and Rossman (2023).
[68] Borchardt (2022).
[69] King (2016) p. 49.
[70] Anonymous (2023*b*).
[71] Anonymous (1889).
[72] Anonymous (1880).
[73] Anonymous (1929).
[74] King (2016) p. 54.
[75] King (2016) p. 55.

In his 1880 Presidential address he reflected on the poor state of science in Australia at that time, especially 'the worthless character of a large proportion of our popular scientific literature' mainly because 'men of real learning have no place among us, and are consequently rarely to be found'.[76] Tenison-Woods encouraged the members of the Society to foster the study of science, influence the public and help each other and students in their endeavours.[77] In his 1881 presidential address he discussed the difficulties of conducting work in the colonies, for example, the lack of access to overseas books and publications as well as the remoteness and difficulties of travelling in the outback.[78]

In his earlier address, Tenison-Woods also discussed Darwinism, which was an interesting topic for a minister of religion. Darwin, he noted, revolutionised the science of zoology more by his 'ingenious and conscientious methods than be his conclusions' which at that time were 'premature to predict'.[79] He acknowledged that there was an 'infinite variety in everything created' and believed that 'if evidence of its (evolution) occurrence were established…it would be one more beautiful illustration of the plan'.[80]

He noted the passion of the small band of members and fellows of the Society and the high quality of their work and publications despite the difficulties.[81] He also commented that most of the research had been conducted in eastern Australia and that the rest of the continent had been ignored.[82] He partly corrected that deficiency himself, by conducting natural history expeditions and geological surveys in central Queensland, Western Australia and the now Northern Territory.[83] Some, however, thought that his endeavours were unworthy. For example, 'Prospector' wrote in a newspaper article that although Tenison-Woods was a clever geologist, his geology expedition in the Northern Territory was a farce, a waste of public money, and would produce only theoretical results.[84]

Tenison-Woods (1880) was acutely aware that in the biological sphere, much attention had been paid to the collection and identification of plants, fish, other vertebrates and invertebrates, but the study of fungi, mosses and lichens had been largely ignored.[85] He noted that the only list and occasional description of Australian fungi up to then had been written by the Englishman Miles Joseph Berkeley in 1873.[86] In that paper Berkeley had listed 235 species of fungi which had been sent to him from the Australian colonies by botanist Ferdinand von Mueller (1825–96), Dr Moritz Richard Schomburgk (1811–91), botanist and curator of the Adelaide Botanic Garden, and others over a twenty-year period.[87] More than 95% were macrofungi (fungi such as mushrooms with large spore-bearing bodies), with only fourteen species of rust and smut fungi and the oomycete *Cystopus candidus* (now *Albugo candida*).[88]

Together with F. M. Bailey, he published a 43-page paper on the fungi of Queensland and New South Wales in 1880, in an attempt to 'furnish a contribution to Australian mycology' and to popularise the subject with a view to 'stimulate enquiry'.[89] Of the 320 fungi (mostly mushrooms) in their publication, most had been sent to England for study by the famous mycologists M. J. Berkeley and C. E. Broome.[90] There are no further publications on fungi which were authored by Tenison-Woods, but Bailey continued collecting in Queensland and in his catalogue of plants in Queensland there are over 800 species in 218 genera of fungi and oomycetes listed, again the vast majority being macrofungi.[91]

Considering that he was 'man of the cloth', Tenison-Woods's views on Darwinism were understandable, but his views on other matters would be considered inappropriate today. In the conclusion section of his report on the geology and mineralogy of the Northern Territory to the South Australian parliament, Tenison-Woods stated that the Chinese should be banned from the mining areas of the Territory and only be present as labourers. He wrote that he had seen much of China and the Chinese, and thought that Australia will 'one day regret any supremacy we give them' for letting the profits from the mineral resources flow back to China. He warned that 'future generations would be amazed at our imbecility in this matter' if Australia let the Chinese become 'proprietors of our treasures'.[92]

Based on the above statements, some might consider that Tenison-Woods was an early advocate of the 'White

[76] Tenison-Woods (1880) pp. 473–474.
[77] Tenison-Woods (1880) p. 477.
[78] Tenison-Woods (1881).
[79] Tenison-Woods (1880) p. 474.
[80] Tenison-Woods (1880) p. 476.
[81] Tenison-Woods (1880) p. 437.
[82] Tenison-Woods (1881) p. 640.
[83] King (2016) pp. 52–53.
[84] "Prospector" (1886).
[85] Tenison-Woods (1880) p. 481.
[86] Tenison-Woods and Bailey (1880) p. 50.
[87] Tenison-Woods and Bailey (1880) pp. 50–51.
[88] Berkeley (1872) pp. 173–174.
[89] Tenison-Woods and Bailey (1880) p. 51.
[90] Tenison-Woods and Bailey (1880) p. 51.
[91] Bailey (1890).
[92] Tenison-Woods (1886) p. 16.

Australia policy' whose sentiment was prevalent at the time and ultimately resulted in the passing of the Immigration Restriction Act of 1901 by the first Australian parliament. That Act excluded potential non-English emigrants (apart from people escaping from some countries of war-torn Europe after World War 2) from entering and settling in Australia until 1959. Others might say that Tenison-Woods was a nationalist and a man of his time, reflecting the beliefs of many of his white Australian country-men and -women.

When he died in Sydney in 1889 Tenison-Woods had published over 150 papers on a wide range of subjects, including geology, palaeontology, fish, lichens, botany, fungi and religion.[93] He is remembered materially by the Tenison Woods Mountain in the D'Aguilar National Park of southeastern Queensland, the Tenison Woods College in Mt Gambier, the Tenison Woods Catholic School in Adelaide, the Father Woods Park in Glenroy (all in South Australia), and the Tenison Woods Centre (part of St Agnes' Catholic Parish) in Port Macquarie, New South Wales.[94]

Certainly, it could said with confidence that Tenison-Woods straddled the second and third stages of natural history studies in Australia as defined by King, especially in his geological and fish studies.[95] However, his mycological contribution in Australia was confined to his collaboration with F. M. Bailey.

Fig. 3. Mr Frederick Manson Bailey, no date or photographer, State Library of Queensland, https://hdl.handle.net/10462/deriv/131876.

Frederick Manson Bailey

Frederick Manson Bailey (Fig. 3) was born in London in 1827 and arrived in Adelaide on 22 March 1839 after his father John was appointed as the South Australian Government Botanist and curator of the Adelaide Botanic Gardens.[96] John Bailey had been a nurseryman and amateur botanist at a then-famous nursery at Hackney near London. Unfortunately, funding for the Gardens was withdrawn only a few years later when the South Australian government ran into financial difficulties.[97] His father set up a nursery in Adelaide where Frederick worked until 1858, apart from a short time when he unsuccessfully tried his hand at gold prospecting.[98]

He then bought a farm in the Hutt River valley in New Zealand but returned to Australian two years later when the Maori Wars broke out. After arriving in Sydney he and his family sailed to Brisbane where in November 1861 he established 'The Adelaide Seed Store' in Edward Street[95] and collected botanical specimens for sale overseas.[99] In 1875, Bailey was appointed as a botanist by a government-funded Board Enquiring into the Diseases of Animals and Plants in Queensland, during which he spent most of his time collecting and identifying potentially poisonous plants.[100]

In December 1880 he was appointed acting curator of the Queensland Museum until March 1882, and in 1881 became the first Colonial Botanist in Queensland.[101] He remained in that position until his death in 1915. During the world financial crisis of the early 1890s, Bailey's position along with many others in the Queensland Government was made redundant but he refused to leave, saying that his work was too important to the people of Queensland and that he would continue without pay. The public outcry forced the government to reinstate him soon after.[102]

Bailey was a prolific writer, publishing books and volumes on ferns, grasses and other plants, culminating in six

[93] Anonymous (2017, 2022).
[94] King (2016) p. 55.
[95] King (2016) p. 50.
[96] White (1944) p. 362.
[97] White (1944) p. 363.
[98] White (1944) p. 363.
[99] Anonymous (1861).
[100] White (1944) pp. 363–364.
[101] White (1944) p. 364.
[102] White (1944) p. 364.

volumes of the Queensland flora (1899–1902) and a catalogue of Queensland plants, including fungi, mosses and ferns in 1909.[103] In his *Queensland Flora*, there are over 260 species (in almost 170 genera) of plants which had been described by Bailey. He was a member of many scientific societies including the Linnaean Society of London and in 1892 was awarded the Clarke Memorial Medal for Outstanding Researchs in Natural Science by the Royal Society of New South Wales.[104]

Bailey was a cataloguer of fungi, rather than a fungal taxonomist. In his *Catalogue of Queensland Plants*[105] over 1250 'species' of fungi are listed, the vast majority (70%) being macrofungi and virtually all having been identified by overseas mycologists.[106] Amongst the remainder there were twenty five smut fungi, fifty one rusts, nine powdery mildews and four downy mildews, and both *Pseudopeziza medicaginis* (Fig. 4) and *Laestadia destructiva*. No descriptions were provided but some fungi, particularly the macrofungi, and others including *P. medicaginis* were illustrated, crudely but relatively accurately, by his grandson Cyril Tenison White.

Bailey was a distinguished-looking man, with a long beard but no moustache and is described by his grandson Cyril Tenison White as a lovable and kindly character with a 'strong' personality who made friends easily.[107] He enjoyed reading English poetry and at the end of the preface of his 1909 *Catalogue of Queensland Plants* included lines from one of William Cowper's poems.[108] In a newspaper article the writer stated that Frederick Bailey had only one ailment—'a lifelong affliction (of) chronic modesty'.[109]

His death was not the end of the Bailey family's contribution to botany in Queensland and Australia. His son John Frederick Bailey was appointed as an assistant to his father in 1889, then became the Director of the Botanic Gardens in Brisbane in 1905 and later in Adelaide in 1917.[110] His grandson Cyril Tenison White was appointed as a pupil assistant to his grandfather, became the Acting Government Botanist for Queensland in 1917 and the Government Botanist in 1918[111] until his death in 1950.[112] He drew the 976 line illustrations in his grandfather's 1912 publication and during his career wrote many hundreds of scientific and 'popular' publications on botany, mostly on weeds, trees and tropical plants.[113] It is most likely that Cyril White's middle name was in honour of his grandfather's friend and colleague, Edmund Tenison-Woods.

Fig. 4. Illustrations of symptoms and signs of *Pseudopeziza medicaginis* on lucerne leaves, and ascus and ascospores, # 844, after Bailey (1909) p. 760, https://www.biodiversitylibrary.org/item/123358#page/800/mode/1up.

Conclusions

It can be stated with some confidence that both Julian Edmund Tenison-Woods and Frederick Manson Bailey were key early advocates of the disciplines of mycology and to a certain extent plant pathology in Australia, prior to the appointments of the first trio of full-time plant pathologists, Daniel McAlpine, Nathan Cobb and Henry Tryon (1856–1943) in the last decade of the nineteenth century. Tenison-Woods and Bailey also fit the criteria for participation in R. J. King's second stage in the evolution of natural history studies in Australia. Daniel McAlpine, the Victorian Government Vegetable Pathologist between 1890 and 1915, who collected, identified and described Australian fungi

[103] White (1944) p. 363.
[104] Anonymous (1915).
[105] Bailey (1899–1902, 1909).
[106] White (1944) p. 366.
[107] White (1944) p. 366.
[108] Bailey (1909) p. 15.
[109] Anonymous (1914).
[110] White (1944) pp. 367–368.
[111] White (1944) p. 368.
[112] Sumner (2022).
[113] Sumner (2022).

(predominantly those associated with plants), was a leader in the third stage of the evolution of mycology and plant pathology in Australia.

The historic confusion over the correct name of the pathogen which causes common leaf spot of lucerne in Australia can be partly attributed to the physical distance and perhaps cultural differences between those who collected fungus specimens in Australia and those overseas scientists who identified, and in some cases, described them. As some mycologists and plant pathologists say—'there is nothing like seeing it for yourself in the field.'

On the rewards of scientific investigation, Tenison-Woods has the last words–

> 'The self-sacrificing workers must find the reward for their labours in the pleasure their studies give them, a pleasure let it be admitted which in most cases compensates them for all else'[114]

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