

## Unwelcome guests

### a selective history of weed introductions to arid and semi-arid Australia

Friedel, M. H.

*Published in:*  
Australian Journal of Botany

*DOI:*  
[10.1071/BT20030](https://doi.org/10.1071/BT20030)

Published: 01/06/2020

*Document Version*  
Publisher's PDF, also known as Version of record

[Link to publication](#)

*Citation for published version (APA):*

Friedel, M. H. (2020). Unwelcome guests: a selective history of weed introductions to arid and semi-arid Australia. *Australian Journal of Botany*, 68(2), 75-99. <https://doi.org/10.1071/BT20030>

#### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

#### Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

# Unwelcome guests: a selective history of weed introductions to arid and semi-arid Australia

M. H. Friedel <sup>A,B</sup>

<sup>A</sup>Research Institute for the Environment and Livelihoods, Charles Darwin University, Grevillea Drive, Alice Springs, NT 0870, Australia. Email: [mhfriedel@outlook.com](mailto:mhfriedel@outlook.com)

<sup>B</sup>Formerly CSIRO Land and Water, Alice Springs, NT 0870, Australia.

**Abstract.** Following European settlement of Australia, numerous plant species were deliberately introduced for use in crops, pastures, gardens and horticulture, and others arrived by chance. Many subsequently escaped and became weedy. Of the 54 weed species of natural environments of arid and semi-arid Australia that are considered here, 27 were apparently accidentally introduced, 20 were intentionally introduced and 7 were probably introduced both accidentally and intentionally. Livestock including camels and their harness, and contaminated seed and hay were the most common vectors for accidental introduction. Amongst intentional introductions, rather more ornamental species appear to have invaded successfully than pasture species, but the former generally occupy niche habitats. Recent new introductions are few due to pre-border, border and post-border protections, but many current arid zone weeds continue to spread. Understanding the history of weed invasions can help to guide current and future management by clarifying pathways for introduction.

**Additional keywords:** camel harness, contaminants of seeds, invasive plants, livestock, vectors.

Received 19 March 2020, accepted 12 May 2020, published online 9 June 2020

## Introduction

Introduced plants were recorded in Australia very soon after European settlement in 1788, when Governor King provided Lord Hobart with ‘Lists of Plants in the Colony of New South Wales that are not Indigenous’ (King 1803). The species included many types of grains, vegetables, fruits and ornamentals. In amongst them were species that escaped and became weedy, and some eventually established far afield in arid and semi-arid Australia (Parsons and Cuthbertson 2001). Since settlement, over 27 000 plant species have been imported into Australia and ~10% have become established in the environment (Groves *et al.* 2005). Of these, over 400 are now part of the arid and semi-arid flora (Scott *et al.* 2018).

The historical context of plant introductions into arid and semi-arid Australia can help to guide current and future management, but historical information is scattered and remains unsynthesised (Scott *et al.* 2018). In this paper I investigate the complex history of plant introductions to arid and semi-arid Australia and provide evidence for the means of arrival for 54 widespread invasive alien species that affect its natural environments. I do not attempt to provide detailed information on the subsequent distribution and spread of species.

## Methods

Arid and semi-arid regions were delineated in accordance with Department of Agriculture, Water and the Environment (2020a) definitions: the arid zone is that which receives an average annual rainfall of 250 mm or less, and the semi-arid zone is that which receives an average annual rainfall of 250–350 mm. The area encompassed by the arid and semi-arid regions (hereafter simply ‘arid’) follows fig. 1(a) in Scott *et al.* (2018).

The number of invasive alien species with more than local impact in arid Australia is debatable. Fifty-four species were identified as belonging in this category from Buckley (1981), Scott *et al.* (2018), Northern Territory Weed Management Branch (unpubl. data) and advice from experts. However, I was unable to identify a common definition of ‘impact’ or determine whether the concept was used consistently amongst the sources, although impact was commonly environmental. Scott *et al.* (2018) considered impacts could be environmental, economic or social and argued that their importance was ‘ultimately subjective’.

To identify pathways and actual or potential points of entry into Australia, I undertook extensive web-based searches of grey literature including Lucid and archived newspaper articles, as well as searches of published articles and books.

Distributions of species within Australia and dates of early records were identified from the Australasian Virtual Herbarium (AVH) and Atlas of Living Australia (ALA), the latter including some records not accessible through AVH in early (2016) searches. The species names given in early records and cited in Appendix 1 may not match the species names in current use, due to taxonomic revisions or misidentification. Such cases are noted in the main text. Readers are referred to the Australian Plant Name Index (APNI) for the history of nomenclature changes. Abbreviations and acronyms (e.g. ALA, APNI, AVH, Lucid) used in the main text and Appendix 1 are listed and identified at the start of Appendix 1, with web addresses.

### Earliest mode(s) of arrival

In total 54 species were investigated, of which 27 were accidentally introduced, 20 were intentionally introduced and 7 were probably introduced both accidentally and intentionally (Appendix 1). In some instances, where evidence for intentional introduction could not be found, introductions were presumed to be accidental and thus the ‘accidental’ category henceforth includes cases with supporting evidence plus cases for which this mode of introduction is presumed.

#### Accidental introduction

##### *Acetosa vesicaria* (L.) A.Löve

Camel harness was almost certainly the source of this species, which was native to the homeland of the cameleers. From the 1860s camels were brought into South Australia (SA) via Port Augusta to service communities, pastoral properties and mines in South Australia, the Northern Territory (NT), New South Wales (NSW) and Queensland (Qld) (McKnight 1969). From the 1880s, camels were imported via Fremantle (near Perth) in Western Australia (WA) predominantly, and other coastal ports to the north, to service Western Australia (McKnight 1969). *Acetosa vesicaria* (synonymous with *Rumex vesicarius*) was first collected near Perth in 1892, and subsequently on camel routes throughout the interior. It was later planted in domestic gardens due to its showy flowers. For example it was introduced to a garden in Alice Springs (NT) by lawyer Beecher Webb’s wife, who brought it from her family home in Broken Hill (NSW) (the location of an earlier camp or ‘Ghantown’ of the cameleers) between 1932 and 1935. It subsequently colonised the surrounding region (M. Hall, D. Nelson, pers. comm.). The species was considered early on as a potentially useful introduction: ‘Another spinach, the *Rumex vesicarias* [*sic*], is one that might be grown here to advantage’, *The Argus* reported in 1868 (Anon. 1868), regarding the growing of plants in ‘the portion of the [Melbourne] Botanic garden devoted to the experimental culture of useful productions’, although I found no evidence that it was ever planted.

##### *Aerva javanica* (Burm.f.) Juss. ex Schult.

Camel harness was also almost certainly the source of ‘kapok bush’. Petheram and Kok (2003) reported that it was

introduced into the north-west of Western Australia by accident in the 1880s, probably in camel harness or fodder. For ~25 years after 1880, camels were off-loaded at Geraldton, Port Hedland and Wyndham in addition to Fremantle (WA) to service the pastoral industry and mines both inland and along the Western Australian coast (McKnight 1969). Nunn and Suijendorp (1954) observed that *Aerva javanica* had grown near homesteads and campsites in the north-west for many years and was thought to have come in camel saddles or fodder or that the crews of the pearling luggers had brought it in mattresses and pillows. The fluffy flower heads were known to have been used in Dhofar, as elsewhere in the Middle East, ‘in stuffing material for pillows and bolsters, and padding for pack saddles for donkeys or camels’ (Miller and Morris 1988). This ‘kapok’ continued to be used in bedding on station properties in Western Australia for some time, which aided spread (Nunn and Suijendorp (1954). The Ord River Regeneration Project (WA) was undertaken from the 1960s, using seed sourced from existing populations of *Aerva javanica* on Anna Plains station in the Pilbara and at Geike Gorge (near Fitzroy Crossing) in the West Kimberley. These populations were understood at the time to have come from camel harness (Alan Payne, pers. comm.). Surprisingly the species does not appear in AVH until 1937, on the de Grey River (WA), which was on the early camel routes.

##### *Alternanthera pungens* Kunth

‘Khaki weed’ was first recorded in New South Wales in 1898 according to Parsons and Cuthbertson (2001), but how it was introduced is unknown. Subsequently it appears that it may have arrived a second time with returning soldiers from the Boer War (1899–1902). Maiden (1920) cited the following from the Agricultural Journal of the Cape of Good Hope, December 1909, p. C58:

In the September issue of the New South Wales Agricultural Gazette, the noxious weed *Alternanthera echinata* Sm., known in Cape Colony as the ‘Amarantus [*sic*] Weed,’ and in the Transvaal as ‘Khaki Weed,’ is credited as being a South African plant. This is not so. It was introduced during the war, probably in forage from the Argentine, the plant being of tropical American origin. This plant has been proclaimed under the Noxious Weed Act.

According to Maiden (1920) South Africans commonly thought it was an Australian plant, and soldiers brought it back to Australia after the war as a curiosity, although he was cautious about asserting this was the source of the weed. Parsons and Cuthbertson (2001) suggested alternatively an association with horses returning from the Boer War, but this was not possible since quarantine regulations in Australia ensured that even those horses that did survive could not return home (Australian War Memorial 2020).

##### *Argemone ochroleuca* Sweet subsp. *ochroleuca*

‘Mexican poppy’ was growing in Sydney Cove (NSW) in 1844 and in George Street Sydney in 1845 according to Parsons and Cuthbertson (2001). Maiden (1920) observed:

It is an old resident of New South Wales, the French botanist Verraux having collected it in George-street, Sydney, in the year 1845!

It is unclear whether this is *Argemone ochroleuca*, which has a creamy white to yellow flower, or *A. mexicana* L., which has a yellow to pale orange flower. There is less doubt as to its identity in Bailey's (1885) report:

This plant has become wild in the neighbourhood of Brisbane [Qld]. Two forms are to be found, one with paler petals than the commoner sort.

Soon after, in 1886, Maiden collected *Argemone ochroleuca* at the junction of the Nepean and Warragamba Rivers in NSW (AVH). Holtze (1887) reported *Argemone mexicana* growing in the Government Botanical Garden at Port Darwin (NT) and it was presented to the Centennial International Exhibition in Melbourne in 1888 by the Queensland Commission as an economic plant of Queensland, being a replacement for castor oil (Bailey 1888). Parsons and Cuthbertson (2001) suggested that Mexican poppy arrived as a contaminant of wheat and, somewhat puzzlingly, that 'there is some doubt as to whether or not *Argemone mexicana* is present.'

#### *Calotropis procera* (Aiton) R.Br. ex W.T.Aiton

The first collection of 'rubber bush' reported in AVH was from Mungana, near Chillagoe, west of Cairns (Qld) in 1935. A railway operated from Mareeba to Mungana to service the nearby copper mines from c. 1900, and camel teams linked the railhead at Mungana to the mines for ~6 years (McKnight 1969). This is a likely source of *Calotropis procera*, especially since '[e]lsewhere in the Middle East, the silk of the fruit has been used to stuff bolsters and cushions' (Miller and Morris 1988). Petheram and Kok (2003) also referred to '...seeds each with silky tufts at one end' and '[t]his silky material is believed to have been imported from Asia and Africa as padding in camel saddles'. Parsons and Cuthbertson (2001) mention naturalisation of *Calotropis procera* around Chillagoe and Georgetown (Qld) c. 1935, while noting that it '...had been present much earlier'. AVH is silent on Georgetown at that time although gold mining had begun at Georgetown in the 1860s. Meadly (1971) suggested that early records may have confused *Calotropis procera* with *Calotropis gigantea* (L.) W.T. Aiton, an early introduction as an ornamental which did not spread from seed but was propagated by cuttings. *C. gigantea* was present in 1885 in the Brisbane Botanic Garden (Qld) (Bailey 1885) and in 1887 in the Government Botanical Garden at Port Darwin (NT) (Holtze 1887).

#### *Carrichtera annua* (L.) DC.

There is little doubt about the source of 'Ward's weed'. Quinn and Andrew (1915) reported that:

the plant must have originated from packing material dumped down on the side of the Three Chain Road leading to Butler's Bridge, about four miles [~6.4 km] from Port Pirie [SA], where the plant now extends over 100 to 200 acres [~40.5–80.9 ha] of land; and further,

the plant was not noticeable more than a couple of years ago. . . This plant, if not exterminated in the near future, is likely to become very widespread.

As well as co-authoring the report, Andrew collected the first herbarium specimen in 1915 (AVH).

#### *Carthamus lanatus* L.

Parsons and Cuthbertson (2001) considered King's 1803 record of 'Carthamus, Bastard saffron' to be a possible first record of *Carthamus lanatus* in Australia. Maiden (1895) believed early records were likely due to confusion with *Carthamus tinctorius* L., the safflower of India, which was subsequently confirmed by Kloot (1983), who reported that bastard saffron was indeed *C. tinctorius*. Maiden (1895) considered the earliest written record of *Carthamus lanatus* to be in South Australian legislation in 1887 aimed at preventing further spread. AVH records show that it was first collected in Stawell, Victoria (Vic.) in 1872. Peirce (1992) cited speculation by several authors about its entry into Australia, including as a possible medicinal plant, as a contaminant of bullock fodder, and as a contaminant of wheat seed.

#### *Cenchrus echinatus* L.

Not much supporting information could be gleaned about the introduction of *Cenchrus echinatus* to Australia. Parsons and Cuthbertson (2001) suggested possible introduction during the Queensland gold rushes of the 1860s and Johnson (1995) stated that:

...the introduction of Mossman River grass (*Cenchrus echinatus*) is associated with the movement of humans to the goldfields of north Queensland [by attachment to humans and their clothes].

Townsville (Qld) was a shipping point for Queensland mines at the time (McKnight 1969) and visiting ships were known to dump contaminated ballast there (Johnson 1995), although no dates were given for this. I note that the first AVH collections were in Townsville in 1901 and 1908. According to The Queenslander (Anon. 1929), the Government Botanist C. T. White said that *Cenchrus echinatus* had been naturalised in Queensland for over 40 years and the article ended with the grass's 'Objectionable Features'!

#### *Chloris virgata* Sw.

According to CABI (2019a) the native range of *Chloris virgata* is not clear because the species is so widespread, but it is possibly native to the Americas. Evidence from early AVH records suggest that it occurred in the homelands of cameleers, since the earliest collections beginning in 1875 were closely associated with the route of the overland telegraph line from Adelaide (SA) to Darwin (NT), the mid-portion of which was built using Beltana camels to supply the construction parties (McKnight 1969). An anomaly would appear to be an 1882 record from Mount Gambier, in south-east South Australia, but an owner of the Moorak run nearby had been Dr W.J. Browne, who took up numerous pastoral properties in South Australia

and experimented with grasses (Anon. 1969). It may be that he encountered *Chloris virgata* on one of his northern South Australian properties, where two camels from the Burke and Wills expedition had strayed (Anon. 2016). In 1886, Lieutenant Herbert Dittrich, a plant collector on David Lindsay's central Australian expedition (Jones 2007), collected *Chloris virgata* 'N of MacDonnell Range' and 'From the Herbert River to Carpentaria' in 1886 (AVH). Poeppel, Carruthers and Wells, during their 1885–86 survey of the Queensland–Northern Territory border using camels, were working in the vicinity of the Herbert River at Lake Nash Station in July 1885 (Steele and Steele 1978), where Lindsay was surveying in April 1886 (Lindsay 1889). Dittrich may have encountered *Chloris virgata* where it escaped Carruthers' and Wells' camel harness in the Lake Nash area.

#### *Citrullus colocynthis* (L.) Schrad.

There seems little doubt 'colocynth' was introduced in ship's ballast, because it was first collected by C. T. White in Townsville (Qld) in January 1923 and was reported to be 'naturalised and common on ballast near wharves' (AVH). However, gene sequencing by Shaik *et al.* (2015) suggested two separate introductions of colocynth, one in the west and one in the east, from two different source populations. Combining their analyses with Dane *et al.*'s (2007) sequencing, Shaik *et al.* (2015) proposed that the eastern population [e.g. Townsville's] was probably introduced from Morocco (potentially via Greece, Cyprus or Turkey) whereas the western population likely originated from Algeria, Chad or Sudan. *Citrullus colocynthis* featured in the 'List of Useful Plants Grown in the Government Botanical Garden at Port Darwin' (Holtze 1887), so may have derived from this latter region. Since botanical gardens in Australia were active in acclimatisation and exchange of non-native species (e.g. Anon. 1868; Bailey 1910; Willis 1961; Morris 1974), I speculate that the Darwin 'coloquint' could have originated with returning soldiers from the Sudan in 1885.

#### *Citrullus lanatus* (Thunb.) Matsum. & Nakai

Gene sequencing indicates that *Citrullus lanatus* in Australia is genetically homogeneous and probably derived from a single source population and a single introduction event (Shaik *et al.* 2015). Shaik *et al.* (2015) suggested that this melon could have come from Africa via India with camels, citing Barker (1964), but Barker does not mention melons. Moreover, Parsons and Cuthbertson (2001) gave the earliest record for this melon as 1836, on Kangaroo Island (SA). This was the year that the island was formally settled by the South Australian Co. and well before camels reached Australia. However, Kangaroo Island had previously been 'settled' from c. 1806 by 'semi-lawless men who were escaped convicts, ships' deserters and sealers' (Marsden 1991) so it seems far more likely that *Citrullus lanatus* was brought by sealers or other seafarers directly from southern Africa, which supports Dane and Liu's (2007) hypothesis of a southern African origin. Parsons and Cuthbertson (2001) also mentioned that *Citrullus lanatus* was being offered for sale

by a Tasmanian nursery in 1845. Although an extensive search of Tasmanian newspapers from that era did not locate such an advertisement, it was clear that nurserymen in Launceston and Hobart were advertising a wide variety of exotic and native plants in 1845.

The earliest AVH record is that of Amalie Dietrich, who made her living in Australia as a collector 1863–72 (Gilbert 1972), and collected *Citrullus lanatus* in 1866 in the Rockhampton area. This area had been settled by the Archer family in 1855 (O'Keeffe 1966), and they may have brought the species with them. The next specimen was collected by Lieutenant Dittrich (see *Chloris virgata*) on Lindsay's expedition in 1886 and his record was as vague as for the earlier species: 'From the Herbert River to Carpentaria' (AVH). However, since Lake Nash Station was stocked in 1879 (Anon. 1879) with cattle from the Rockhampton area (Cawarral), he may have collected it in the Lake Nash area.

#### *Conyza bonariensis* (L.) Cronquist

Ludwig Leichhardt collected *Conyza bonariensis* at Telligerry Creek (NSW) [vicinity of modern-day Port Stephens] in 1842 (AVH). Kloot's (1983) examination of Bentham's *Flora Australiensis* showed that Behr, Mueller and others had collected it 'near Adelaide and other places about St Vincent's Gulf' (SA) in 1848. Kloot (1983) concluded that it was a 'very common weed found around settlements and probably introduced accidentally and very early.' It is likely that *Conyza bonariensis* arrived as a contaminant of seeds and grain (CABI 2017a) and was readily dispersed by wind (Wu 2007; CABI 2017a).

#### *Cucumis myriocarpus* Naudin

Like *Citrullus lanatus*, *Cucumis myriocarpus* is genetically homogeneous, suggesting a single 'genetically impoverished founder event' and a single source population (Shaik *et al.* 2015). However, it and 'all invasive populations across the globe' share the same genetic profile but differ from that of the native African source populations, which are more genetically diverse (Shaik *et al.* 2015). This led Shaik *et al.* (2015) to propose a shared origin developed via a 'stepping-stone pathway'. There were numerous opportunities for contaminated livestock to reach Australia, starting with the arrival of the First Fleet in Sydney Cove (NSW) in 1788, bringing ~6 (accounts vary on numbers) draft Zebu cattle and 70 'fat tail' sheep from the Cape of Good Hope (Burrenuick 1932; Pearson and Lennon 2010). Several more lots of cattle, including Zebu and Bengali, were brought to Sydney during the 1790s from the Cape of Good Hope, Calcutta or the west coast of America (Pearson and Lennon 2010; Campbell *et al.* 2014). Similarly, a 'slow trickle' of Cape sheep arrived from 1791 and, in 1792, Bengali sheep were delivered as well as Spanish sheep from California (Pearson and Lennon 2010).

The earliest collection of *Cucumis myriocarpus* in Australia appears to be that of Mueller on the River Torrens, near Adelaide (SA) in 1847 (Kloot 1983); South Australia's livestock industries had begun in 1838 with cattle and sheep being driven overland from New South Wales

(Primary Industries and Regions SA 2017), which may have been the immediate source of the species. Subsequently it was recorded from widely different areas. An AVH record from 1874 reported ‘fruit found on sheep brought to Melbourne [Vic.] from up the country.’ And explorer Ernest Giles collected the species ‘between Spencer Gulf and Mt Eba’ (SA, west of Beltana) according to an ALA record (MEL. 0593027A) located 28 July 2016. This record could not be accessed subsequently, but Giles’ location dates his find to 1875.

*Eragrostis barrelieri* Daveau

The first AVH records, at the State Herbarium of South Australia, date from August 1883 when Tate collected *Eragrostis barrelieri* between Lake Torrens and modern-day Leigh Creek (SA) (‘Depot Creek to Mt Parry’), and again somewhat to the north of this location in the same month (‘Mt Parry’) (AVH). Both were within ~60 km north of Beltana, where Thomas Elder had his camel stud, and on the major camel train route north from Port Augusta (McKnight 1969). Five years later, Tate again collected the species, this time in ‘Lake Torrens Basin, E. Depot Creek’ (AVH), on the same camel route and ~40 km north of Port Augusta. The next collections were made at Alice Springs (NT) (1896), Mt Lyndhurst (SA) (1898) and Broken Hill (NSW) (1912), all places associated with camels (McKnight 1969). Since *Eragrostis barrelieri* is native to the home of the cameleers (Appendix 1, and see McKnight 1969 for origins of cameleers), it is probable that it arrived in camel harness.

*Eragrostis cilianensis* (All.) Vignolo ex Janch.

There are few clues to the source of *Eragrostis cilianensis*, common name ‘stink grass’. It was first recorded at Manly (NSW) in 1885 (AVH). Manly had been visited at the time of Sydney Cove settlement in 1788 and settlers subsequently eked out a living fishing and farming (Manly Council 2019). In the intervening years to 1885 it became a popular holiday destination. Records for the next 25 years were largely from New South Wales (AVH), although this may reflect where collectors were active, but it is now widely naturalised throughout most of Australia (Lucid). The species is regarded as native to all continents except the Americas, and is likely to have been an accidental contaminant, since it is not palatable:

sheep refuse to eat it [AVH; Cowra, NSW, 1907]

and it ‘stinks’:

[i]ts scent drew my particular attention [AVH: Port Jackson district, NSW, 1906].

*Eragrostis minor* Host

AVH records of *Eragrostis minor* were largely confined to Queensland, from the first collection at Rockhampton in 1907 until the 1960s. Collections in the 1930s by Hubbard note the occurrence of the species along railway lines but this reflects Hubbard’s sampling route, although it is also possible that the species was distributed by rail traffic. Despite *Eragrostis*

*minor* being a species native to the home of cameleers (Appendix 1), there was no evidence of camels in the Rockhampton area following pastoral settlement in 1860 (Bird 1904), so the source remains unknown. Another ‘odorous’ and weedy *Eragrostis* (AusGrass2 2010a), it is likely to have been an accidental contaminant.

*Eragrostis trichophora* Coss. & Durieu, also known as *E. cylindriflora* Hochst.

First collected in 1971 on a research farm in Alice Springs (NT) (AVH), *Eragrostis trichophora* was reported in 2010 by Simon as ‘introduced fairly recently into Australia and ... becoming widespread along roadsides...’ (AusGrass2 2010b). Its occurrence at a research farm and ‘[a]round weighbridge at Tangaratta Stockfeeds Pty. Ltd., north west of Tamworth [NSW]’ in 1997 (AVH) suggests it may have been a contaminant of hay. Whether this is the case or not, it presumably arrived in Australia from its African origin as a contaminant, with goods or people.

*Neurada procumbens* L.

‘Neurada’ was detected for the first time in 2000, along a remote roadside ~150 km south-east of Alice Springs (NT) (Albrecht *et al.* 2002). These authors pointed out that, although *Neurada procumbens* is native to the region which provided camels to Australia, importation of camels ceased in 1907, making it unlikely that they were the vector, but not completely impossible without further knowledge of how long the spiny fruit persists. Albrecht *et al.* (2002) considered it more likely that the species was introduced by overseas visitors arriving with fruit adhering to clothing or equipment, especially since the known population, ‘a single linear metapopulation approximately 13 km long following the road alignment’ was largely restricted to the roadside when first detected.

*Parthenium hysterophorus* L.

The earliest record of *Parthenium hysterophorus* in AVH is dated 1950, although most literature on the species states that it was first recorded in 1955 (e.g. Haseler 1976; Watson 1979; Auld *et al.* 1982; Navie *et al.* 1996; Parsons and Cuthbertson 2001). The location of the 1950 and 1955 records was Toogoolawah, ~100 km north-west of Brisbane (Qld). Parsons and Cuthbertson (2001) proposed that movement of aircraft and machinery during the Second World War was responsible. A second, more aggressive, introduction was detected in 1964 in central Queensland (AVH; Everist 1976) and was attributed by Everist (cited in Haseler 1976) to the importation of contaminated seed from the United States of America in 1958. According to AVH (BRI AQ0249996) it was:

[p]ossibly introduced with Kleberg’s blue grass seed imported from Texas and aurally sown 1959–60.

*Passiflora foetida* L.

Although the species is largely a weed of tropical environments, it has invaded favourable microhabitats in arid

Australia such as Millstream in Western Australia (Webber *et al.* 2014). The earliest located record of ‘stinking passion flower’ was from NSW in 1854, where *Passiflora foetida* was reported at a Sydney flower show (Anon. 1854). This may account for the 1875 AVH record ‘in gardens of Queensland’ if the species proved popular. There are subsequent records at Cooktown and later Port Douglas and Cairns in the 1880s and ‘90s, right through to 1920 at Yeppoon (AVH). These records may simply reflect when plant collectors were active, but they suggest a gradual expansion of Queensland populations from 1875. How it arrived in Australia could not be determined, but web searches revealed its widespread use for medicinal purposes in Asia, so it is possible it arrived in Cooktown when the Palmer goldfields were active in the 1870s (see also *Senna occidentalis* below). Additionally, it may have been introduced as an ornamental. Holtze (1892) was concerned that it was suffocating the native vegetation around Fannie Bay, Darwin (NT) only 10 years after its introduction, but he did not say from where or how it was introduced, although he referred to its potential for spread by birds and Aboriginal people (‘natives’). There is some taxonomic uncertainty regarding the origins of ‘stinking passion flower’ invasions in Western Australia (Webber *et al.* 2014), but it appears to have originated from central or south America. The first AVH record outside Queensland was for Western Australia near Derby in 1921. American whalers were active on Western Australia’s Pilbara coast in the 1840s (McDonald *et al.* 2019), and presumably northward to the Kimberley, providing a potential source for Western Australian populations, other than those suggested above.

#### *Senna occidentalis* (L.) Link

The seeds of ‘coffee senna’ were reputed to be used as a coffee substitute but also as a treatment for ringworm in Oman (Miller and Morris 1988; Parsons and Cuthbertson 2001). In several other countries parts of the plant have been used for a diversity of medicinal purposes and the seeds for making coffee, and yet it is also considered to be poisonous (Wikipedia 2019a). Perhaps it was as a coffee substitute that it was carried to the Endeavour River near Cooktown (Qld), to be discovered in 1883. Otherwise it may have arrived accidentally in mud attached to footwear, equipment or livestock, or in hay or grain, once Cooktown became the port for the export of gold from the Palmer goldfields in the 1870s (Wikipedia 2019b).

#### *Solanum nigrum* L.

‘Black nightshade’ was first recorded in 1847 (AVH), collected at Settlement Point, Flinders Island, Tasmania (Tas.) by the resident surgeon Joseph Milligan. Milligan was also a geologist, a recorder of Aboriginal language and ‘one of the most indefatigable and able of Tasmanian botanists’ according to J.D. Hooker (Hoddinott 1967). Mueller collected specimens in the Adelaide (SA) area in 1848 and 1850 (AVH) and Waterhouse collected it on Kangaroo Island (SA) in 1861 (Kloot 1983; Kellermann 2007). Kloot (1983) thought *Solanum nigrum* was ‘Of uncertain introduction, probably as a garden weed’, but it is

also possible it arrived with the sealers and other seafarers (see *Citrullus lanatus*), since it had been used for thousands of years for food and medicinal purposes, despite its known toxicity (Wikipedia 2019c).

#### *Sonchus oleraceus* L.

The first record of *Sonchus oleraceus* in AVH was collected in 1838 in Fremantle (WA), the port for the Swan River colony that had been newly established in 1829 and that later became Perth, the capital of Western Australia. Almost certainly it was carried as a contaminant in the crops of the early settlers, as it was elsewhere in the world (CABI 2014). There may have been multiple points of entry, since the species was recorded by Ludwig Leichhardt in 1844 some 250 km south-west of modern-day Gladstone (Qld) (Leichhardt 1847) and it was already considered a weed around Adelaide (SA) in 1847 (Kloot 1983).

#### *Tribulus terrestris* L. (non-native)

Morrison and Scott (1996a, 1996b) established that populations of *Tribulus terrestris* from Queensland and the Northern Territory were genetically different to southern Australian and northern Western Australian populations, and that the latter two were similar to those from the United States of America, southern Africa, the Mediterranean and the Middle East. Morrison and Scott (1996a, 1996b) concluded that the former two were probably native, the latter two were introduced and that at least two separate introductions were likely; they also considered that the southern populations were most likely to have originated in the Mediterranean or West Asian regions. The first record of *Tribulus terrestris* in AVH is that of Mueller, who collected it on the Murray River in Victoria in 1853. Although this could be associated with the movement of livestock, the same could not be said for the second record, also Mueller’s, which was collected from ‘Gilbert River. N.E. Australia’. This places the record at the base of Cape York (Qld), and suggests it is the native form. The third record is also potentially native, since it was collected by Beckler, the botanist on the Burke and Wills expedition of 1860, in far western New South Wales [some 150 km south-east of modern-day Tibooburra], well before pastoral settlement of the area. The date of the fourth record, 1863, of Maitland Brown’s collection at Nickol Bay (WA) appears to be incorrect, as he was a member of Francis Gregory’s expedition to the area in 1861 (Waterson 1972). Livestock were introduced to the area after Gregory’s expedition, when de Grey Station was established from c. 1862, so it seems that this collection was either a native specimen or arguably could have originated from maritime explorers who were known to have visited the west coast of Australia before 1769 (Bean 2007, especially fig. 4).

#### *Vachellia farnesiana* (L.) Wight & Arn

*Vachellia farnesiana* is native to central America, but it had arrived in Australia before 1788, via the Philippines according to Kodela and Tindale (2001). Bean (2007) argued more plausibly that it came from Taiwan with the Dutch explorers, given that ‘popinac (*Acacia farnesiana* [sic]) ...

and others' were introduced from America and became naturalized during the Dutch occupation of Taiwan (1624–1662) (Yan *et al.* 2001). Bell *et al.* (2017) did not find evidence of an introduction from central America to Australia via the Philippines or via Spain. Instead they found that Australia's *Vachellia farnesiana* was 'genetically unique' and may represent a significantly older introduction. This could be consistent with introduction via Taiwan but has not been tested. Early Australian collections that pre-date pastoral settlement are referenced by Bean (2007), who quoted five undated citations by Bentham. The first 'NW Coast, Cunningham' does not appear in AVH but the location and date can be identified through the Australian Dictionary of Biography (Perry 1966) as Exmouth Gulf-Cossack (WA) during the 1818 Phillip Parker King survey of the northern Australian coast. The other records (1843–1856) are represented in AVH (see Appendix 1), including 1843 'Plains of the Condamine [Qld]' collected by Ludwig Leichhardt. The species has multiple uses (Wikipedia 2019d) so may have been carried by seafarers for their own use or for trade.

#### *Xanthium occidentale* Bertol

'Noogoora burr' was so named due to its first appearance as a weed on a 6-square mile (~16-km<sup>2</sup>) block on the Brisbane River (Qld) called Noogoora, which had been used to grow cotton (White-Haney 1930; Carew 1934). According to White-Haney (1930) it was generally accepted that the burr arrived with cotton seed, and the seed was of American cotton, but the source was not known. Carew (1934) cited his father 'and other old hands' as saying that the seed came from India, whereas Parsons and Cuthbertson (2001) suggested either India or the Mississippi Delta of the United States of America. The time of introduction is given variously as 1850s (Hocking and Liddle 1986) or 1860s (White-Haney 1930; Parsons and Cuthbertson 2001). The cotton enterprise 'was soon abandoned as unprofitable', but the burr spread rapidly (Hocking and Liddle 1986). Bailey (1885) reported Noogoora burr as 'this dangerous weed', indigenous to 'East India', in the Brisbane Botanical Garden, but Hocking and Liddle (1986), quoting Michael (1981), said that the burr was native to the southern United States of America, Mexico and the West Indies but had been widely introduced elsewhere 'especially India and Pakistan'.

#### *Xanthium spinosum* L.

According to Maiden (1920) 'Bathurst burr' came originally 'from Valparaiso, Chili [*sic*], South America' in the tails of horses in the 1840s and he added 'I think it came to Twofold Bay [NSW] first'. Hocking and Liddle (1986) suggested it may alternatively have been introduced as an impurity in grain 'in the first half of the 19th century' and gave the Twofold Bay date as 'about 1830'. John Macarthur is reported to have observed Bathurst burr on the Nepean River (NSW) 'as early as the 1830s' (Parsons and Cuthbertson 2001). The burr got its name following its arrival in Bathurst (NSW) 'via Molong' not many years after reaching Twofold Bay and 'was first noticed on the site of

the Old Black Bull Inn' (Maiden 1920). The first record in AVH is not until 1882, when it was collected at Port Stephens (NSW). Kloot (1987a) remarked, regarding South Australia, that:

the first collection located of *Xanthium spinosum* is from 1904, although that species had been the subject of the Thistle and Burr Act of 1862.

#### Accidental and intentional introduction

##### *Cenchrus ciliaris* L.

There is little doubt that 'buffel grass' was introduced into Australia in camel harness. As outlined for *Acetosa vesicaria* above, camels were brought into South Australia via Port Augusta to service communities, pastoral properties and mines in South Australia, the Northern Territory, New South Wales and Queensland from the 1860s and, from the 1880s, camels were imported via Fremantle (near Perth, WA) predominantly, and other coastal ports to the north, to service Western Australia (McKnight 1969). The earliest record of the species is from 1887, and was collected by Charles Nylasy, the warden at the Pilbara Goldfields (WA), in the 'Kimberley District. Ord [River] near Wyndham track' (AVH). This was the track to Hall's Creek, site of a gold rush in 1885–86, and the river crossing is a likely location to rest camels and restuff saddles. Camels carrying mining provisions were overlanded from Derby in the first instance but, from 1886 when Wyndham Port was established, the main route for the camels was between the Port and Hall's Creek (McKnight 1969). Camels were also off-loaded at Albany, Geraldton and less commonly Port Hedland in Western Australia (McKnight 1969), the latter on the north-west coast. Marriott (1955) reported that buffel grass was introduced to Western Australia between 1870 and 1880 at coastal Wallal, 'some 150 miles [~241 km] E.N.E. of Port Hedland', as an escapee of camel harness. It was subsequently said that Joe Moore, a Port Hedland storekeeper, brought the seeds from Wallal in 1910 and encouraged its spread (Humphreys 1967). Wallal as a source is unlikely. The only camels in the region in the 1870s were two survivors of Warburton's expedition (Warburton 1875) that were left at de Grey Station in 1874. Camel imports to Western Australia did not begin until the 1880s and probably the largest shipment ever made to Australia was in 1907 and it landed at Port Hedland (McKnight 1969). This was likely to have been Joe Moore's source of seed. There is no doubt he encouraged its spread (Burnside 2018) and AVH records from the 1920s–1930s show how successful his efforts were. Of the 32 AVH records (excluding duplicates) to 1950, 20 could be associated with camel cartage routes or depots (McKnight 1969) and Joe Moore's seed distribution, 10 were from experimental introduction sites and 2 were of unknown origin.

After the First World War, the Western Australian Department of Agriculture distributed *Cenchrus ciliaris* and other *Cenchrus* species, sent by Field Marshall Baron William Birdwood from India, to station properties in the region (Anon. 1934a). Buffel grass was planted in experimental plots and on station properties in NSW and Queensland by the 1920s (AVH;



Humphreys 1967). Cameleer Walter Smith, speaking of the period from 1914 to the 1930s, described deliberate spread of buffel grass along camel routes from Oodnadatta (SA) to Alice Springs and northwards to Newcastle Waters (NT) and out to cattle stations and missions.

[Cameleers] carried small cloth parcels of seeds and, at favoured localities such as the good soil at watering points, loosened the soil, broadcast the seeds, covered them over, and then watered the area [Kimber 1997].

Subsequently, government agencies actively sought seed from diverse locations for plant introduction trials (Marriott 1955; Millington and Squires 1980; Albrecht 1985; Cook and Dias 2006).

*Cenchrus pennisetiformis* Hochst. & Steud.

Camel harness was almost certainly the source of *Cenchrus pennisetiformis*. This species was first collected in 1915 in the Geraldton district of Western Australia (AVH), Geraldton being a location for off-loading camels, as was Port Hedland (McKnight 1969), where the second collection was made in 1922 (AVH). The third record, in 1930, was from Tea Tree Well (NT) (AVH), where cameleers were known to rest and restuff harness (Scherer 1993), and the fourth, in 1931, was in Cloncurry (Qld) (AVH). As McKnight (1969) wrote:

Both copper and gold were mined in several localities in the Cloncurry district in pre-camel days, but by the 1890s there were hundreds of camels at work in the area.

Evidence that camel harness was the source of 'Cloncurry buffel' has been detailed by Hall (1978). Intentional introduction followed, as for *Cenchrus ciliaris* (Hall 1978; Millington and Squires 1980; Albrecht 1985).

*Cenchrus setaceus* (Forssk.) Morrone

'Fountain grass' was sold as an ornamental plant outside its North African home from the late 19th century and seeds were available for sale in the United States of America in 1883 (CABI 2017b). It first appeared in AVH records in 1903 at Eurelia (SA). Eurelia was a small town ~60 km east of Port Augusta providing for the local farming community, with a railway station and a population of over 100 at the time (Flinders Ranges Research 2019). The source of the initial introduction, and hence whether introduction was accidental or intentional, is unknown. It took until the 1930s for *Cenchrus setaceus* to appear again in AVH, when it was collected in Queensland, New South Wales and Western Australia. At what point intentional introduction occurred is not clear.

*Cynodon dactylon* (L.) Pers.

Bean (2007) argued that *Cynodon dactylon* is alien, while acknowledging arguments for both alien and indigenous origins. 'It was certainly present at Sydney soon after settlement' (Bean 2007) and 'even the 'native' forms present in northern Australia probably came from a very early (i.e. possibly pre-European) introduction' (Lucid). The earliest record in AVH is Leichhardt's in 1843 from 'Mr MacKenzie's flat' [modern-day Kilcoy, near Brisbane, Qld].

AVH records are prolific and drawn from all states by the 1870s. An extensive list of cultivars and dates of release are available at Tropical Forages (2017a).

*Dichanthium annulatum* (Forssk.) Stapf

*Dichanthium annulatum* first appears in AVH in 1856, collected by Mueller in the headwaters of the Victoria River (NT) during the Augustus Gregory North Australian Exploring Expedition (Project Gutenberg Australia 2014). The headwaters are 500 km from the river mouth, so it is unlikely that the grass was introduced during an earlier exploration of the river by Captain J.C. Wickham in 1839 since Wickham's party travelled upstream only some 200 km (Wikipedia 2017). It seems more likely that the grass arrived with maritime travellers from the north before British settlement (Bean 2007) since it is native to south-east Asia, including Indonesia and Papua New Guinea (Appendix 1). Much later the grass was 'repeatedly intentionally introduced in tropical and subtropical regions to be used as fodder, forage, hay and silage crop' (CABI 2019b) and is valued in Australia for the same purposes (Tropical Forages 2017b).

*Emex australis* Steinh.

One of the reported common names for *Emex australis* is 'Cape spinach', which reflects its early history in Australia.

In 1830 the ship Margaret left Bristol, England, with passengers for the Swan River settlement, Western Australia, and during the voyage called at Capetown, South Africa, where one of the intending settlers procured some seeds of the so-called Cape spinach ... with the view of cultivating it in the land of his adoption ... it has proved to be one of the most obnoxious and aggressive weed pests ever acclimatised in Australia [Turner 1912].

It was cultivated along the Canning River in 1833:

Mr. William Tanner, on his way out to Fremantle in 1831, with Mr. D. Wainsborough, obtained some seed at the Cape and the latter sowed a bed with the seed at Mr. J. Phillips' place on the Canning River in 1833. It did not prove a palatable spinach and soon became a troublesome weed ... it received the name of 'Tanner's Curse' [Anon. 1910].

Its subsequent spread in Western Australia was attributed largely to livestock (Gardner 1930). *Emex australis* has also been known as 'prickly jacks' and, under this name, its arrival in South Australia was described in *The Advertiser* (Anon. 1934b).

E. Linklater, of Brighton, tells me that his father, who arrived here in 1840, declared that Dr. Nash, who was on his way in a sailing ship to South Australia, called at the Cape and purchased hay for his horse. From this hay the 'Jacks' started in South Australia. Dr Nash settled near Seacliff, and it was from this place that the plants spread all over the sandhills, and sheep carried the seeds further north.

The first record in AVH is Mueller's, collected in the vicinity of Adelaide in 1848.

*Vachellia nilotica* subsp. *indica* (Benth.) Kyal. & Boatwr.

The nomenclature for *Vachellia nilotica* subsp. *indica* is complex and whether early records are of this subspecies or of *Vachellia nilotica* (L.) P.J.H.Hurter & Mabb. cannot always be determined. Mackey (1997) and Parsons and Cuthbertson (2001) did not always make the distinction in their considerations. The earliest record of *Mimosa nilotica* is in King (1803), at Sydney Cove (NSW). Because ships travelling to the colony of Sydney Cove sailed from England via Rio de Janeiro and the Cape Colony (Maiden 1914), this species is likely to be of African origin. The first record of *Mimosa nilotica* in AVH was collected at Apsley River (no state specified) in 1887. According to the Council of Heads of Australasian Herbaria (2017) the collector was A. R. Crawford, who worked in the Apsley River region of New South Wales. This AVH specimen is now identified as *Vachellia nilotica* subsp. *indica* in AVH.

Searches for *Acacia arabica* in AVH were directed to the *Vachellia nilotica* subsp. *indica* page. As listed in Appendix 1, *Acacia arabica* was advertised for sale in 1845 at J. Bailey's nursery, Adelaide (SA) (Bailey 1845) and it was also listed as present in 1887 in the Port Darwin Botanical Garden (NT) (Holtze 1887), potentially as a result of active exchange amongst botanical gardens of that era (Bailey 1910; Morris 1974). *Acacia arabica* Willd. 'the *Mimosa arabica* of Lamark and Roxburgh', was presented at the Centennial International Exhibition in Melbourne in 1888 as one of the economic plants of Queensland, used for 'gum arabic', tanning and as a tonic (Bailey 1888).

J. Bailey also advertised *Acacia nilotica* for sale as a separate entity in the same catalogue in 1845 (Bailey 1845). The first AVH record is that of Maria Crouch, one of many collectors for Mueller (Council of Heads of Australasian Herbaria 2017), who collected *Acacia nilotica* at Nichol [Nickol] Bay near Karratha (WA) in 1874. This specimen is now listed as *Acacia nilotica* (L.) Del. in AVH. The second AVH record with the same nomenclature was also collected in Western Australia, 50 km inland from Coral Bay, in 1885. I note that in a review of the invasive subspecies *indica*, 'prickly acacia', Mackey (1997) did not consider the subspecies to be present in Western Australia at the time (1997). However it was recognised not long after, in 2002, growing by a Kimberley (WA) roadside (Department of Natural Resources, Mines and Energy 2004). Subsequent searches in the Kimberley identified a large specimen very close to the remains of the old Nulla Nulla homestead, established on an Aboriginal reserve in 1921, and which I speculate may have been deliberately planted as a shade tree (Wikipedia 2019e; N. Wilson, pers. comm.). The source is unknown but, as is apparent from the evidence, prickly acacia was already in Australia and sharing plant seeds was common. Subsequent spread was attributed to livestock transport (N. March, pers. comm.) and it is now an important weed in Western Australia (CRC for Australian Weed Management 2003a). Mackey (1997) noted high variability in morphology of the

subspecies and the potential for hybridisation, and reports of introductions from Africa as well as India.

The first record of *Vachellia nilotica* subsp. *indica* in AVH is dated 1883, collected by Eugene Fitzalan (another of Mueller's collectors: Council of Heads of Australasian Herbaria 2017) as '[c]ultivated at Port Denison, Qld', near Bowen. The Crawford record (above), from New South Wales in 1887, is the second. The records are somewhat at odds with reports that prickly acacia was first introduced into Queensland in the 1890s from Pakistan and India for shade and fodder (Mackey 1997; CRC for Australian Weed Management 2003a). Note that it was also reported that prickly acacia was 'initially introduced into Rockhampton, Queensland by the botanist Fitzalan in the late 1800s as a source of gum arabic' (Johnson 1995). Consequently, I suggest that the subspecies or related entities reviewed above may have been introduced deliberately more than once as well as accidentally.

#### Intentional introduction

##### *Arundo donax* L.

In May 1845, J. Bailey's Hackney Nursery advertised *Arundo donax* for sale (Bailey 1845) and, in 1885, F. M. Bailey, Colonial Botanist, reported it present in the Brisbane Botanic Garden (Qld) (Bailey 1885). The earliest record in AVH was collected at Gosford (NSW), in 1894 and was 'not cultivated', so 'giant reed' had already escaped cultivation. It was widely planted as an ornamental (Lucid), but Csurhes (2016) listed many uses including:

...wind-break, erosion control, saline ground reclamation, garden ornamental, paper production, treatment of waste water (removal of nutrients), forage and, more recently, as a potential source of biofuel.

He cites evidence from Ahmad *et al.* (2008) suggesting that a single genetic clone has been cultivated in multiple regions of the world but there have been no studies to ascertain if Australian populations are the same clone (Csurhes 2016).

##### *Asphodelus fistulosus* L.

'Onion weed' was probably introduced as an ornamental (Parsons and Cuthbertson 2001). It was growing in the Melbourne Botanic Garden (Vic.) in 1857 and in the Adelaide Botanic Garden (SA) in 1858 (Parsons and Cuthbertson 2001), and first appeared in AVH as a record from Clarendon, near Adelaide (SA) in 1881, followed by Queenscliffe [*sic*] (Vic.) in 1884. It was proclaimed a weed in Victoria by 1895 (Parsons and Cuthbertson 2001).

##### Cactaceae

*Cylindropuntia fulgida* var. *mamillata* (A.Schott ex Engelm.) Backeb. The literature that I located regarding *Cylindropuntia fulgida* var. *mamillata*, 'coral cactus' or 'boxing glove cactus', was general to invasive cacti, reporting that they had been introduced for ornamental purposes, stock feed or hedging (e.g. Australian Weeds Committee 2012; Novoa *et al.* 2015). Although some species e.g. *Opuntia stricta* were specifically noted as used

for stock feed or hedging, there was no indication that ‘coral cactus’ was introduced for any purpose other than ornamental. Interestingly it reportedly does not produce flowers or fruit (Lucid), with one exception (Australian Weeds Committee 2012). It was first recorded in AVH as late as 1984, when it was collected from an abandoned garden at the Radium Hill Mine Reserve (SA), ‘[s]ome plants about 300 m from original garden’ and from a roadside planting near the Parachilna Hotel (SA). When it was introduced could not be determined.

*Cylindropuntia imbricata* (Haw.) F.M.Knuth. By 1911 ‘devil’s rope cactus’ was growing in gardens in New South Wales and had escaped into the bush (Maiden 1911a).

[It] is said to have been introduced to this district as a flower-garden shrub, in the garden of the local parsonage [but] [s]ome of the ridges around Sofala are fairly thickly covered with it, and I am informed that the plant is becoming prevalent along the river so far as Turondale [Maiden 1911a].

How the species was introduced into Australia is not known but it may well have occurred through plant exchange as described for *Opuntia aurantiaca* below. It seems to have been planted for ornamental purposes only (e.g. Hodges 2014) and it does not appear in AVH until 1934, at Quirindi (NSW). Late record dates in AVH may be due to the difficulty of collecting and processing succulent and spiny specimens.

*Opuntia aurantiaca* Lindl. Information about the introduction of ‘tiger pear’ was not readily locatable. Parsons and Cuthbertson (2001) said that the history of introduction is not known and that it was first noted in New South Wales in 1883. Referring to *Opuntia aurantiaca*, CABI (2017c) remarked that ‘[i]t was fashionable in the nineteenth century for collectors of exotic plants in Europe to exchange specimens with other collectors’ and that the same was true in Australia (e.g. Morris 1974). Tiger pear arrived in Cape Town c. 1843 almost certainly by plant exchange with collectors in England (Moran and Annecke 1979) and CABI proposed that this was probably the case for Australia too. ‘In both cases, [tiger pear] was distributed as a garden ornament to settlers who also used it as a barrier plant and for protecting graves’ (CABI 2017c). Maiden (1911b), New South Wales Government Botanist, received specimens from two different sources in the Hawkesbury area (NSW) in 1906, and he was aware of its weedy potential:

[t]his species has been known for many years in south west Queensland . . . where it has obtained a great hold.

*Opuntia stricta* (Haw.) Haw. Parsons and Cuthbertson (2001) suggested *Opuntia stricta* was brought to Australia:

in the early days of settlement possibly as an ornamental shrub, a hedge plant, a fodder crop or as a food plant for cochineal insects. . .

‘Prickly pear’ appears to have been a collective name for a variety of *Opuntia* species early on, for example, Maiden (1914) noted:

Prickly Pear was introduced to Australia (the number of species is unknown) from Rio de Janeiro when Governor

Philip [sic] touched at that port on his outward voyage. . .

Maiden (1914) goes on to list several *Opuntia* species in addition to *Opuntia inermis* DC, an earlier name for *Opuntia stricta*, so it is unclear on which species Governor Phillip’s cochineal insects arrived in Australia. Mann (1970), cited by Hosking *et al.* (1988), reported that *Opuntia stricta* was growing in cultivation in Parramatta (NSW) before 1839 and that a potted plant was taken to Scone (NSW) in that year.

From here joints or cuttings were taken to many areas of New South Wales and Queensland for use as pot plants or hedges.

It was taken from New South Wales to Warwick (Qld) in 1848 as a garden plant (Tanner 2015) and planted widely by early settlers in New South Wales and Queensland as drought fodder as well as hedging around homesteads. By 1870 it was causing concern and by 1886 the first legislation was enacted in New South Wales requiring its control (Tanner 2015).

#### *Cenchrus setiger* Vahl

Although ‘Birdwood grass’ originated in the homeland of cameleers, it arrived in Australia through the efforts of Field Marshall Baron William Birdwood. Birdwood was born in India and served on the North West Frontier (between Afghanistan and India) and in South Africa before going on to greater heights in the First World War (Hill 1979). A few years after the war, while he was living in India, he sent seeds of *Cenchrus setiger* in a matchbox to the brother of his daughter’s husband Colin Craig, living at that time on Mundabullangana Station (Anon. 1934a; Hardie 1981) ~100 km south-west of Port Hedland (WA).

Gordon [Craig] planted the seed in a moist area under a tap, went to Perth and on returning 19 days later found that the seeds had germinated, grown and were developing seed heads [Hardie 1981].

As reported for *Cenchrus ciliaris*, the Western Australian Department of Agriculture actively distributed ‘*Cenchrus* lines’, including *Cenchrus setiger*, to pastoral properties during the 1920s (Anon. 1934a; Humphreys 1967) and it first appeared in AVH in 1932 at Roebourne (WA), one of the introduction sites (Anon. 1934a).

#### *Melinis repens* (Willd.) Zizka

‘Red natal grass’, as *Panicum teneriffæ* R.Br., was growing in the Bowen Park grounds of the Queensland Acclimatisation Society in 1885 (Bailey 1885) and had been provided to the Society by Dr Schombergh of the Adelaide Botanical Garden in 1876 (Bailey 1910). Seed was sent to the United States Department of Agriculture trial gardens between 1891 and 1894, where red Natal grass was being cultivated for its forage value, although it was also grown as an ornamental (Stokes *et al.* 2011). Macpherson (1894) wrote that the seed was readily windblown:

and I have no doubt the red grass may be found on many allotments in and around Brisbane. . . There are several

hundreds of miles of railway intersecting vast portions of the colony. If a man were to start with his eyes open, carry a small bag of the red Natal grass seed, take a chance of a windy day and throw out a small pinch of the seed here and there as he proceeds, choice grasses might in this way be largely disseminated.

There is no record to indicate whether his advice was followed.

#### *Nicotiana glauca* Graham

The worldwide history of introduction and spread of *Nicotiana glauca* is summarised in CABI (2013): ‘wild tobacco’ was most commonly introduced as a garden and landscape ornamental, although Steenkamp *et al.* (2002), cited by CABI (2013), reported contaminated horse feed as a source. Spread was subsequently deliberate or accidental. It appears that *Nicotiana glauca* was first introduced to Australia as a garden plant, since Bentham’s *Flora Australiensis* described it as ‘Escape [*sic*] from gardens’ (Kloot 1983). Kloot (1983) went on to say:

This plant was introduced to Adelaide from Melbourne about 1847 by Mr. F.M. Dutton and one box was given to Bailey’s Hackney Nurseries [Anon. 1894 in Kloot 1983].

The earliest record in AVH is that of Mueller in 1850, who collected it on the River Torrens, Adelaide Hills (SA). It was not collected outside South Australia until 1884–5, when it was recorded near outback Bourke (NSW) and the Warrego River (Qld).

#### *Orbea variegata* (L.) Haw.

I was unable to locate information about the arrival of ‘carrion flower’ in Australia. It first appeared in AVH in 1967, when T.R.N. Lothian collected it at ‘Hyde Park (near Broken Hill Proprietary [*sic*] Nursery) 1 mile [~1.6 km] W of Whyalla [SA]’.

It is believed to have been introduced to the region as an easy-care garden perennial [Dunbar and Facelli 1999].

By 1985, Hudson (1985) had discovered eight separate populations in the Whyalla region and there were additional records in AVH. It was collected at Wallumbilla in south-east Queensland in 1969 and cultivated in Tasmania in 1982. Carrion flower is naturalised in South Australia, Kalgoorlie (WA) and inland south-east Queensland (Lucid). It appears it was widely distributed as a garden plant and, at the time of writing, it was available for sale on a variety of websites.

#### *Parkinsonia aculeata* L.

‘Parkinsonia’ was widely introduced around the world from the eighteenth century (van Klinken *et al.* 2009). It was often first introduced as an ornamental tree in towns and botanic gardens, but also for other uses such as hedging (Hughes 1989, cited by van Klinken *et al.* 2009). In 1876, von Mueller (1876) was promoting *Parkinsonia aculeata* as an evergreen hedge plant for the warmer parts of Victoria: ‘The flowers are

handsome’, he reported. *Parkinsonia* was presented to the Centennial International Exhibition in Melbourne in 1888 as an economic plant of Queensland, for its use as a hedge-making plant (Bailey 1888). However, less than 20 years later, Bailey (1906) reported its invasiveness in the Fitzroy River area of central Queensland. Van Klinken *et al.* (2009) proposed its introduction to that area could have been as early as the 1860s, soon after settlement, and this seems altogether possible given the establishment of the Brisbane Botanic Garden in 1854 and the Queensland Acclimatisation Society in 1862, and their enthusiasm for plant introduction (Bailey 1910). Earliest records located were 1885 in the Brisbane Botanic Garden (Bailey 1885), 1894 in the Melbourne Botanic Gardens (Vic.) (AVH) and 1901 in the Sydney Botanic Garden (NSW) (AVH). Genetic analyses by Hawkins *et al.* (2007) showed that *Parkinsonia aculeata* in Australia was likely to have originated from South America, as Bailey (1906) had indicated, possibly from a single introductory event.

#### *Phoenix dactylifera* L.

The Afghan cameleers are often associated with date palms in Australia and there is no doubt that they grew them in their Ghantowns and in extensive plantations as well as distributed them where they travelled (Stevens 1989; M. H. Friedel, pers. obs.). However, J. Bailey’s Hackney Nursery (SA) was advertising them for sale in 1845 (Bailey 1845), 15 years before the first cameleers arrived in Australia, and it was present in ‘Captain Wickham’s garden, Newstead’ in Brisbane (Qld) in 1856 (Bailey 1910). The first Queensland plantation ‘was one formed by Mr Barnes, in Mackay, prior to 1868’ (Bailey 1910). The South Australian Government planted three hundred palms at various locations in the north of that state between 1884 and 1887, although with little long-term success (Stevens 1989). During that time cameleer Abdul Kadir planted 9 acres (3.6 ha) with date palms on his land outside Hergott Springs (now Maree) and laboriously hand pollinated them in the absence of the pollinating bees native to his country. According to Stevens (1989) these palms were probably part of an 1884 consignment for South Australia from Saudi Arabia. Abdul Kadir’s date plantation was a commercial success and his dates and seeds were popular with Afghan people who used them to grow their own date palms. The Afghans were likely to have carried the fruit on the camel route between Adelaide (SA) and Alice Springs (NT) (Stevens 1989), and, I would suggest, on the many camel routes in northern South Australia and the Northern Territory, where the palms can still be found at remote springs. Independently, The Hon. John Lewis, South Australian parliamentarian and leaseholder of the Dalhousie Springs (SA) area, sent a box of dates to the property and in 1899 requested that the seeds be planted out. Later he was pleased that some young ones were growing (AusEmade 2015). Date palms subsequently became invasive around the mound springs at Dalhousie (Noack 1994), as they did at Millstream Station (WA) where they had been planted in the nineteenth century by the leaseholders for shade and beautification along the Fortescue River (Keighery 2010).

*Prosopis* spp. – Mesquites

The taxonomy of *Prosopis* spp. in Australia is complex (Parsons and Cuthbertson 2001; van Klinken and Campbell 2009). Although four species, *Prosopis glandulosa*, *Prosopis juliflora*, *Prosopis pallida* and *Prosopis velutina*, are reputed to be present in Australia on the basis of morphological attributes, genetic analysis suggests that *Prosopis juliflora* may only have been present as populations from two sites, one of which has since been eradicated (van Klinken and Campbell 2009; R. van Klinken, pers. comm.). The earliest *Prosopis* records are those of Bailey (1910) who reported:

Algaroba Bean (*P. juliflora*) and Mesquit (*P. pubescens*) introduced by the Brisbane Botanic Gardens and Acclimatisation Society in 1877. Received from Honolulu.

Confusingly, Bailey (1885) reported the presence in 1885 in the Brisbane Botanic Gardens of *Prosopis glandulosa* Sorr. ‘Mesquit or Algaroba of Texas’ from West Texas, *Prosopis juliflora* DC. (no common name) from Jamaica and *Prosopis pubescens* Benth. ‘Screw Bean or Screw Mesquit’ from Texas – and no mention of Honolulu. Presumably in light of revised taxonomy, van Klinken and Campbell (2009) described the first recorded *Prosopis* plant as being *Prosopis pallida*, ‘planted in the early 1880s’ in the Brisbane Botanic Gardens. Complexity is increased by multiple introductions of mesquite into Australia and by hybrids, which are difficult to distinguish, occurring in different localities (van Klinken and Campbell 2009).

A further record, for 1886, for an unidentified *Prosopis* species, appears in AVH for a locality ‘N of Macdonnell [*sic*] Range; Plenty River, Marshall River, Milne River, Lake Nash’. The collector was Lieutenant Dittrich, and the ‘locality’ simply describes the route of David Lindsay’s 1886 survey expedition (see *Chloris virgata* and *Citrullus lanatus*). Dittrich was not a careful collector and ‘had a major falling-out with Lindsay by the expedition’s end’ (Jones 2007). Lindsay’s nephew was less diplomatic than his uncle (Lindsay and Lindsay 1952):

Dietrich [*sic*] was a supposed German scientist who accompanied the party on behalf of the Baron von Mueller. The term ‘supposed’ is used because this man proved to combine Prussian arrogance in an extreme form with a woeful inefficiency as a scientist. The botanical collection which he made on the trip was allowed to become worthless through mould developing on it. . .

and, one could add, his inadequate record keeping. The plant may have been encountered at Lake Nash Station but this and how it arrived in the region is only surmise. The station had been stocked in 1879 (Anon. 1879) from a Costello property near Rockhampton, but no records could be found of *Prosopis* in that area at the time.

References to *Prosopis* species in Appendix 1 reflect morphologically based identifications at the time of first observation or at subsequent re-examinations of herbarium specimens, and so are not necessarily consistent with van Klinken and Campbell’s (2009) modern taxonomic

interpretation, based on genetic analyses. Thus, species identities in Appendix 1 should be treated with caution. The history of introduction of individual species or varieties has been described where possible by van Klinken and Campbell (2009) and is not repeated here.

*Ricinus communis* L.

‘Castor oil plant’ has been grown for medicinal purposes for thousands of years (Miller and Morris 1988; CABI 2017d). Not surprisingly it appeared soon after European settlement in 1788, as ‘Palma Christi’, in King’s (1803) list of plants at Sydney Cove. In addition to its medicinal value, it was planted for ornamental purposes (Lucid) and was reported by the South Australian Government Botanist to be flowering in the old Adelaide Botanical Garden in 1841 (Bailey 1841). Indeed it was ‘apparently naturalised [in South Australia] during the 1840s’ (Kloot 1983). It was growing in the Brisbane Botanic Garden (Qld) in 1861 the Director of the Garden reported, and it had ‘since become a great weed on our waste lands’ (Bailey 1910). Gardener and botanist Maurice Holtze (1892) listed *Ricinus communis* as ‘introduced during these last 20 years’ in the Darwin (NT) area and escaped from cultivation. It did not appear in arid Northern Territory and New South Wales collections until 1955 and in arid South Australia until the 1960s (AVH). It is currently advertised for sale on the internet as ‘Palma Christi’ (castor oil) for health and beauty purposes.

*Sorghum × alnum* Parodi

‘Columbus grass’ was introduced into Australia by CSIRO in the 1940s as a forage crop (NSW WeedWise 2014). After widespread planting in central and southern Queensland it spread to localised areas of western New South Wales and NT (NSW WeedWise 2014); it was first recorded in arid central Australia in 1983 (AVH; Flora NT 2013).

*Tamarix aphylla* (L.) H.Karst

Valued as a windbreak and a source of wood in semi-arid areas, various *Tamarix* species became widespread in the south-western United States of America after they were introduced from the mid-nineteenth century onwards (Shafroth *et al.* 2005, citing Robinson 1965). Essington Lewis (Blainey and Smith 1986), son of John Lewis (see *Phoenix dactylifera*), followed in his father’s footsteps and introduced *Tamarix aphylla* to Whyalla (SA) in the 1930s, having seen it growing in California (Parsons and Cuthbertson 2001). Lewis worked for the Broken Hill Proprietary mining company and subsequently took ‘tamarisk’ (or ‘athel pine’) from the Whyalla works to Broken Hill (NSW) in 1936. Tamarisk became popular in the outback as a shade tree and windbreak and was widely planted well before the potential for *Tamarix* spp. to become serious invaders of arid river systems was recognised in the 1960s in the United States of America (Shafroth *et al.* 2005, citing Robinson 1965) and in the 1970s in Australia (CRC for Australian Weed Management 2003b).

*Ziziphus mauritiana* Lam.

Parsons and Cuthbertson (2001) suggested that ‘Chinee apple’ (or ‘Indian jujube’) was so named because it was associated with Chinese miners during the 1860s gold rushes in Queensland. They also suggested that it was first recorded in 1842 in Mr Stevenson’s garden in North Adelaide (SA) as Chinese jujube, citing McEwen (1842), but McEwen (1842) gives the species as *Ziziphus jujuba*. According to Grice (2002) and APNI, the two species may be treated as taxonomic synonyms, although AVH lists them separately. ‘Chinee apple’ was planted for its horticultural value and is often associated with early mining settlements (Grice 2002). The earliest record in AVH for *Ziziphus mauritiana* is for the Etheridge River (Qld) in 1886. Gold was detected at Etheridge [now Georgetown] in 1868 and a gold rush ensued the following year. The population of Chinese miners in the Etheridge–Gilbert area reached 430 by 1871 (Burke and Grimwade 2013), giving credence to the suggested source of the common name. A further AVH record at ‘Pandanus Creek’ (no state specified) in 1911 almost certainly relates to the establishment in 1904 of a stamper battery for a gold mine at Pandanus Creek in north Queensland (Wikipedia 2016). However, the species was established in the Brisbane Botanic Garden (Qld) as early as 1864 (Bailey 1910), in addition to *Ziziphus jujuba* in North Adelaide (SA) in 1842 (McEwen 1842). The geographic origin of Chinee apple in Australia is unknown (Grice 2002).

**Discussion**

Of the 54 species considered here, including the 7 that were introduced both accidentally and intentionally, there were a total of 34 accidental introductions and 27 intentional introductions. Hence, the proportion of species that were accidentally introduced was 57% of the total. In South Australia in 1984, the proportion of plants accidentally introduced that had become established (56%) was greater than the proportion of established, intentionally introduced plants (44%), which Kloot (1987b) remarked could be due to the competitive advantage of ‘weedy’ characteristics. In Queensland, 53% of highly successful introductions were accidental, compared to a total of 47% for three classes of intentional introductions: ornamental, crops and pastures (Johnson 1995). Keighery’s (2010) categories for 104 established weeds of the Pilbara (WA) are not directly comparable because they were limited to the purpose of intentional introduction. Only 7 were categorised as ‘accidental’ and 22 were ‘unknown’, and the list of ‘intentional’ introductions included species that had previously arrived accidentally. The list also included species that were largely confined to towns (Keighery 2010). Consequently, for South Australia, Queensland and the more constrained number of widespread arid zone species presented in this study, it appears that accidental introductions generally represent somewhat over half of all alien naturalised species.

The history of intentional plant introduction in Australia has been well covered (e.g. Lonsdale 1994; Groves *et al.* 2005;

Cook and Dias 2006), the history of accidental introductions less so. As Kloot (1987c) has pointed out:

The means of accidental introduction, whilst clear in principle, are very rarely documented in practice and

As with intentional introductions, it is rarely possible to be certain that any particular means of entry was the source of present infestations.

In the present study, the evidence for the mode of accidental introduction has been relatively well documented in some cases, whereas in others I have indicated in the text where conclusions are speculative. The most common modes of accidental introduction (Table 1) are similar to those for South Australia and Queensland, which is by contaminated seed, fodder and hay, ballast, clothing and footwear (‘people’), livestock, machinery and packaging (Kloot 1987b; Johnson 1995). Some accidental introductions in the present study occurred across more than one mode, which had no equivalent in data presented by Kloot (1987b) or Johnson (1995). In addition, some modes were further subdivided here, in particular ‘livestock’, showing that camel harness was likely to have been an important source of accidental introduction, exceeded only by contaminated seed and hay (Table 1).

Regarding intentional introductions, garden plants make up 70% of all invasive plants Australia-wide (Groves *et al.* 2005) and likewise for South Australia (Kloot 1987b). Equivalent proportions are not available in Johnson (1995), but intentionally introduced ornamentals occurred much less commonly in Queensland Herbarium collections than intentionally introduced pasture species. In the arid zone, a larger number of intentionally introduced ornamentals were invasive than intentionally introduced pasture plants but the numbers are small (Table 2). Moreover, ornamentals may be confined to niche habitats compared with widespread pasture plants. Species usually considered of subtropical-tropical origin e.g. *Arundo donax*, *Phoenix dactylifera*, *Ricinus communis*, have successfully invaded moister environments, such as river frontages and springs, within generally arid environments (Keighery 2010). Not surprisingly, crop species do not appear in the list of introduced invasive plants in Table 2, due to climatic limitations.

Arid zone weed species came most commonly from the Middle East, South Asia, North Africa and South America (Table 3). The figures may be somewhat misleading because some species originated in more than one region, even though historical records may show that one region was the likely source of initial invasion, e.g. early *Cenchrus ciliaris* invasion most likely originating from South Asia. However, it seems intuitively reasonable that successful invaders would come from similar arid environments while species from European or Mediterranean climates would be less likely to persist. Direct comparisons with other states are difficult due to differences in definitions of regions. Additionally, climate and landscape differences within Queensland (Johnson 1995), South Australia (Kloot 1987a), Western Australia’s Pilbara region (Keighery 2010) and arid Australia will have

**Table 1. Potential mode(s) of arrival for accidental introductions**

'Camel harness', 'livestock', 'people', 'seed or hay', 'equipment', 'packaging' and 'ballast' are likely sources of accidental contamination, post-European settlement; 'maritime travellers' includes pre-European settlement traders of Dutch and British origin, Macassans and sealers and whalers. 'Medicinal or horticultural' refers to species which may have been perceived to have medicinal or horticultural value in their country of origin. There may be more than one mode of arrival for an individual species

Species	Camel harness	Livestock	People	Maritime travellers	Seed or hay	Equipment	Packaging	Ballast	Medicinal or horticultural	Unknown
<i>Acetosa vesicaria</i>	x									
<i>Aerva javanica</i>	x									
<i>Alternanthera pungens</i>		x	x							x
<i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i>					x					
<i>Calotropis procera</i>	x									
<i>Carrichtera annua</i>							x			
<i>Carthamus lanatus</i>										x
<i>Cenchrus ciliaris</i>	x									
<i>Cenchrus echinatus</i>			x					x		
<i>Cenchrus pennisetiformis</i>	x									
<i>Cenchrus setaceus</i>										x
<i>Chloris virgata</i>	x									
<i>Citrullus colocynthis</i>			x					x		
<i>Citrullus lanatus</i>				x						
<i>Conyza bonariensis</i>					x					
<i>Cucumis myriocarpus</i>		x								
<i>Cynodon dactylon</i>				x						
<i>Dichanthium annulatum</i>				x						
<i>Emex australis</i>					x					
<i>Eragrostis barrelieri</i>	x									
<i>Eragrostis cilianensis</i>										x
<i>Eragrostis minor</i>										x
<i>Eragrostis trichophora</i> also known as <i>E. cylindriflora</i>					x					
<i>Neurada procumbens</i>			x							
<i>Parthenium hysterophorus</i>					x	x				
<i>Passiflora foetida</i>				x					x	
<i>Senna occidentalis</i>		x	x		x	x			x	
<i>Solanum nigrum</i>									x	
<i>Sonchus oleraceus</i>					x					
<i>Tribulus terrestris</i> (non-native)				x						
<i>Vachellia farnesiana</i>				x						
<i>Vachellia nilotica</i> subsp. <i>indica</i>		x								
<i>Xanthium occidentale</i>					x					
<i>Xanthium spinosum</i>		x								
Total	7 (16%)	5 (11%)	5 (11%)	6 (14%)	8 (18%)	2 (5%)	1 (2%)	2 (5%)	3 (7%)	5 (11%)

enhanced or limited the success of invasive species. Kloot (1987b) reported that South Australia's weed flora was predominantly from the Mediterranean, Europe and South Africa, whereas Queensland's was predominantly from the 'Old World Tropics', the 'New World Tropics' and the Mediterranean (Johnson 1995). Pilbara (WA) weeds mainly originated from the Americas, Asia and Africa (Keighery 2010).

Some weedy arrivals may have been an accident of history. For example, South America and southern Africa became early sources of weeds in Australia because Rio de Janeiro and the Cape Colony were ports of call for shipping en route from Britain to Australia (Maiden 1920; Kloot 1987a). Ships also

visited the Cape Colony and Calcutta [Kolkata] from Sydney Cove (NSW) for food supplies (Maiden 1920). However, a great many species arrived in Australia and were subsequently distributed far and wide through the diligence of acclimatisation societies and Government Botanists (Cook and Dias 2006). Exchange amongst botanic gardens and distribution of species for trial plantings was common from the 1860s (e.g. Bailey 1910). Baron Sir Ferdinand von Mueller was one such advocate for plant exchange (von Mueller 1876).

Apart from his critical taxonomic faculties, Mueller also looked upon vegetation through the eyes of the geographer, the forester, agriculturalist and pharmacist [Willis 1961].

**Table 2. Purpose of intentional introductions**

'Livestock feed or shade' includes grasses, shrubs and trees; 'horticulture' includes fruit, vegetables and flowers for sale; 'ornamental' includes plants grown in public and private parks and gardens, for example for beauty or shade; 'hedging' includes barriers, windbreaks and screens. An individual species may have been introduced for more than one purpose

Species	Livestock feed or shade	Horticulture	Ornamental	Hedging	Medicinal
<i>Arundo donax</i>			x		
<i>Asphodelus fistulosus</i>			x		
Cactaceae examples					
<i>Cylindropuntia fulgida</i> var. <i>mamillata</i>			x		
<i>Cylindropuntia imbricata</i>			x		
<i>Opuntia aurantiaca</i>			x	x	
<i>Opuntia stricta</i>	x		x	x	
<i>Cenchrus ciliaris</i>	x				
<i>Cenchrus pennisetiformis</i>	x				
<i>Cenchrus setaceus</i>			x		
<i>Cenchrus setiger</i>	x				
<i>Cymodon dactylon</i>	x				
<i>Dichanthium annulatum</i>	x				
<i>Emex australis</i>		x			
<i>Melinis repens</i>	x				
<i>Nicotiana glauca</i>			x		
<i>Orbea variegata</i>			x		
<i>Parkinsonia aculeata</i>			x	x	
<i>Phoenix dactylifera</i>		x	x		
Mesquites		x		x	
<i>Prosopis glandulosa</i>					
<i>Prosopis juliflora</i>					
<i>Prosopis pallida</i>					
<i>Prosopis velutina</i>					
<i>Ricinus communis</i>			x		x
<i>Sorghum × almum</i>	x				
<i>Tamarix aphylla</i>			x		
<i>Vachellia nilotica</i> subsp. <i>indica</i>	x		x		
<i>Ziziphus mauritiana</i>		x			
Total	10 (31%)	3 (9%)	15 (47%)	3 (9%)	1 (3%)

As Director of the Melbourne Botanic Gardens,

he was responsible for exchanging seeds and plants with botanists throughout Australia as well as European and American herbaria [Morris 1974],

and he enlisted the help of non-specialists to trial species in new environments. In 1872, explorer Ernest Giles planted seeds, given to him by Mueller, near Glen Helen in central Australia (NT):

Among these were blue gum (tree), cucumbers, melons, culinary vegetables, white maize, prairie grass, sorghum, rye and wattle-tree seeds [Giles 1889].

At the remote Hermannsburg Mission in central Australia (NT) in 1879 the missionaries planted seed supplied by Mueller to see what crops would do well.

Everything was tried, from dates and apricots, to sweet potatoes and bananas [Strehlow 2011].

Perhaps fortunately the climate was too harsh for many of these to survive.

Examining the introduction of 155 grass species in northern Australia, van Klinken *et al.* (2015) found ~85% had first been recorded before 1940 and 90% naturalised before 1980, naturalisation being defined according to Richardson *et al.* (2000). Of the 54 arid zone species reported here (Appendix 1), all but 6 were first recorded before 1940 and 44 were first recorded before 1900. Van Klinken *et al.* (2015) estimated that, for 77 tropical grass species, the time between introduction and naturalisation averaged ~30 years but could be as high as 124 years. For longer lived woody perennials in South Australia Caley *et al.* (2008) estimated a likely mean time to naturalisation of 149 years. It could be assumed that many of the 54 arid zone species were naturalised due to the elapsed time since first recording and their widespread distribution, but available information was not sufficient to confirm it. However, it appears that the rate of naturalisations has slowed due to declining numbers of new species colonising the arid zone.

New plant introductions have not ceased, but they have been constrained by the establishment of pre-border, border and post-border protections, especially since the 1990s (Department of Agriculture, Water and the Environment



**Table 3. Regions of origin**  
Wikipedia definitions have been used to standardise regions or countries listed in Appendix 1

Species	Europe	Mediterranean	Middle East	South Asia	China	Northern Africa	Southern Africa	North America	Central America	South America
Accidental introduction										
<i>Acetosa vesicaria</i>			x			x				
<i>Aerva javanica</i>			x	x		x	x			
<i>Alternanthera pungens</i>										x
<i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i>								x		
<i>Calotropis procera</i>			x	x		x				
<i>Carrichtera annua</i>		x	x							
<i>Carthamus lanatus</i>	x	x								
<i>Cenchrus echinatus</i>									x	x
<i>Chloris virgata</i>				x		x	x	x	x	x
<i>Citrullus colocynthis</i>			x			x				
<i>Citrullus lanatus</i>							x			
<i>Conyza bonariensis</i>										x
<i>Cucumis myriocarpus</i>							x			
<i>Eragrostis barrelieri</i>		x	x			x				
<i>Eragrostis cilianensis</i>	x		x	x	x	x				
<i>Eragrostis minor</i>		x	x	x	x					
<i>Eragrostis trichophora</i> also known as <i>E. cylindriflora</i>			x			x	x			
<i>Neurada procumbens</i>			x	x		x				
<i>Parthenium hysterophorus</i>								x		x
<i>Passiflora foetida</i>								x	x	x
<i>Senna occidentalis</i>								x	x	x
<i>Solanum nigrum</i>	x	x	x	x	x					
<i>Sonchus oleraceus</i>	x		x			x				
<i>Tribulus terrestris</i> (non-native)		x								
<i>Vachellia farnesiana</i>									x	x
<i>Xanthium occidentale</i>								x	x	
<i>Xanthium spinosum</i>										x
Total accidental introduction	4	6	12	7	3	10	5	6	6	9
Accidental and intentional introduction										
<i>Cenchrus ciliaris</i>				x		x	x			
<i>Cenchrus pennisetiformis</i>				x		x	x			
<i>Cenchrus setaceus</i>			x			x				
<i>Cynodon dactylon</i>						x				
<i>Dichanthium annulatum</i>			x	x		x	x			
<i>Emex australis</i>							x			
<i>Vachellia nilotica</i> subsp. <i>indica</i>				x		x				
Total accidental and intentional introduction	0	0	2	4	0	6	4	0	0	0
Intentional introduction										
<i>Arundo donax</i> <sup>A</sup>										
<i>Asphodelus fistulosus</i>		x	x	x						
Cactaceae examples										
<i>Cylindropuntia fulgida</i> var. <i>mamillata</i>										x
<i>Cylindropuntia imbricata</i>								x		
<i>Opuntia aurantiaca</i>								x		x
<i>Opuntia stricta</i>								x	x	x
<i>Cenchrus setiger</i>				x		x				
<i>Melinis repens</i>			x	x		x	x			
<i>Nicotiana glauca</i>										x
<i>Orbea variegata</i>							x			
<i>Parkinsonia aculeata</i>								x	x	x
<i>Phoenix dactylifera</i>			x	x		x				
Mesquites										
<i>Prosopis glandulosa</i>								x	x	
<i>Prosopis juliflora</i>								x		
<i>Prosopis pallida</i>										x
<i>Prosopis velutina</i>								x		
<i>Ricinus communis</i>						x				
<i>Sorghum</i> × <i>almum</i>										x
<i>Tamarix aphylla</i>			x	x		x				
<i>Ziziphus mauritiana</i>				x		x				
Total intentional introduction	0	1	4	6	0	6	2	7	3	7
Total accidental introduction, accidental and intentional introduction and intentional introduction	4 (3%)	7 (6%)	18 (15%)	17 (14%)	3 (3%)	22 (18%)	11 (9%)	13 (11%)	9 (8%)	16 (13%)

<sup>A</sup>Origin 'contentious'.

(2020b). The development of plant and particularly seed trading on the internet has increased the chances of new incursions or unwitting distribution of weedy species already in Australia. McLaren (2008), citing King (2005), reported that

a quick search showed 15 million ‘mail order plants’ global web sites, and 5 million ‘mail order seeds’ global web sites [in 2005].

Given this, surprisingly few known weeds have penetrated pre-border and border protection barriers recently.

Incursion of new potential weeds into the arid zone no doubt continues to occur, but few species become established e.g. *Eragrostis trichophora* (first recorded 1971), *Cylindropuntia fulgida* var. *mamillata* (1984) and *Neurada procumbens* (2000). Nevertheless, some already established weed species that appear to be insignificant contributors to the arid zone flora may prove to be ‘sleepers’ (Groves 1999), and recognised weeds will continue to spread, e.g. *Cenchrus ciliaris* (Lawson *et al.* 2004), via wind and water, people, vehicles, livestock, transport corridors and wildlife. Knowing the most likely pathways of introduction of invasive plants through examination of the historical record can help to prevent invasion and inform targeted management. As a point of historical interest, the expanding distribution in remote arid Australia of *Cenchrus ciliaris* is likely to be enhanced through seed spread by feral camels, whose harnesses first brought it to Australia.

### Conflicts of interest

The author declares that she has no conflicts of interest.

### Declaration of funding

This research did not receive any specific funding.

### Acknowledgements

This paper would not have been possible without the support of CSIRO Library staff, who located many obscure documents at short notice. Colleagues who also provided much valuable assistance included Rieks van Klinken, John Scott, Garry Cook, Bruce Webber, Karen Bell and Raghu Sathyamurthy. Dick Kimber volunteered many historical records from his collection and the Alice Springs Town Library was also most helpful. Several people provided quotable ‘personal communications’ which are acknowledged in the text; their help was greatly appreciated. Both Charles Darwin University and Desert Knowledge Australia provided a congenial workplace during the development of this work. I also acknowledge the valuable comments provided on earlier drafts of this paper by Bruce Strong, Dane Panetta and an unnamed reviewer.

### References

- Ahmad R, Liow PS, Spencer DF, Jasieniuk M (2008) Molecular evidence for a single genetic clone of invasive *Arundo donax* in the United States. *Aquatic Botany* **88**, 113–120. doi:10.1016/j.aquabot.2007.08.015
- Albrecht DE, Barker RM, Barker WR, Gavin J (2002) *Neurada procumbens* L. (Neuradaceae): a new record for Australia and a potential threat to Australia’s sandy deserts. *Plant Protection Quarterly* **17**, 158–161.
- Albrecht R (1985) Patience proves pasture possibility. *Northern Territory Rural News* **11**(3), 4–7.
- Anon. (1854) Flower show. In *The Sydney Morning Herald*, Saturday 30 December, p. 5. Available at <https://trove.nla.gov.au/newspaper/article/28640819> [Verified 17 December 2019]
- Anon. (1868) *The Argus*, Saturday 8 February 1868, p. 5. Available at <https://trove.nla.gov.au/newspaper/page/220650> [Verified 25 September 2018]
- Anon. (1879) Port Curtis. In *The Queenslander*, Saturday 16 August 1879, p. 217. Available at <https://trove.nla.gov.au/newspaper/article/20327996> [Verified 7 May 2019]
- Anon. (1894) *Journal of the Bureau of Agriculture* **7**, 211.
- Anon. (1910) Noxious weeds and poison plants. Illustrated. For the guidance of settlers. Department of Agriculture, Western Australia. Bulletin number 32. (Government Printer: Perth, WA, Australia)
- Anon. (1929) Mossman river grass. *Cenchrus echinatus*. In *The Queenslander*, Thursday 12 September 1929, p. 7. Available at <https://trove.nla.gov.au/newspaper/article/22918089> [Verified 23 March 2017]
- Anon. (1934a) Birdwood grass. A valuable importation. In *The West Australian*, Thursday 28 June 1934, p. 9. Available at <https://trove.nla.gov.au/newspaper/article/32959980> [Verified 10 April 2018]
- Anon. (1934b) Prickly jacks 80 years ago. In *The Advertiser*, Wednesday 19 December 1934, p. 25. Available at <https://trove.nla.gov.au/newspaper/article/35026752> [Verified 11 September 2018]
- Anon. (1969) Browne, William James (1815–1894). In ‘Australian Dictionary of Biography’. (National Centre of Biography, Australian National University, Canberra, ACT, Australia) Available at <http://adb.anu.edu.au/biography/browne-william-james-3087> [Verified 12 February 2019]
- Anon. (2016) William Oswald Hodgkinson. In ‘Burke and Wills Web’. Available at [http://www.burkeandwills.net.au/Explorers/Additional\\_Members/hodgkinson.htm](http://www.burkeandwills.net.au/Explorers/Additional_Members/hodgkinson.htm) [Verified 29 August 2016]
- Auld BA, Hosking J, McFadyen RE (1982) Analysis of the spread of tiger pear and parthenium weed in Australia. *Australian Weeds* **2**, 56–60.
- AusEmade (2015) Dalhousie homestead ruins. Available at <http://www.ausemade.com.au/sa/destination/w/witjira-np/dalhousie-ruins/dalhousie-homestead-images-4.htm> [Verified 8 March 2017]
- AusGrass2 (2010a) *Eragrostis minor*. In ‘AusGrass2: Grasses of Australia’. Available at <http://ausgrass2.myspecies.info/content/eragrostis-minor> [Verified 30 January 2019]
- AusGrass2 (2010b) *Eragrostis trichophora*. In ‘AusGrass2: Grasses of Australia’. Available at <http://ausgrass2.myspecies.info/content/eragrostis-trichophora> [Verified 30 January 2019]
- Australian War Memorial (2020) Australia and the Boer War, 1899–1902. Available at <https://www.awm.gov.au/articles/atwar/boer> [Verified 18 May 2020]
- Australian Weeds Committee (2012) Weeds of National Significance. Strategic plan: Opuntoid cacti (*Austrocylindropuntia*, *Cylindropuntia*, *Opuntia* spp.) 2012 to 2017. (Australian Weeds Committee: Canberra, ACT, Australia)
- Bailey FM (1885) ‘Catalogue of Plants in the Two Metropolitan Gardens, the Brisbane Botanic Garden and Bowen Park (the Garden of the Queensland Acclimatisation Society).’ (Government Printer: Brisbane, Qld, Australia)
- Bailey FM (1888) ‘A Sketch of the Economic Plants of Queensland. Centennial International Exhibition, Melbourne 1888.’ (Queensland Commission: Brisbane, Qld, Australia)
- Bailey FM (1906) ‘Weeds and Suspected Poison Plants of Queensland.’ (H. Pole & Co.: Brisbane, Qld, Australia)
- Bailey FM (1910) Introduction of economic plants into Queensland. *Proceedings of the Royal Society of Queensland* **22**, 27–102.
- Barker HM (1964) ‘Camels and the Outback.’ (Sir Isaac Pitman & Sons Ltd: Melbourne, Vic., Australia)
- Bailey J (1841) Plants in flower in the month of June. In *The South Australian Magazine* 1841, Vol 1, p. 30. Available at <http://www.nla.gov.au/ferguson/14402149/18410700/00010001/31-38.pdf> [Verified 11 September 2018]

- Bailey J (1845) Hackney Nursery, Adelaide. Catalogue of plants cultivated in and for sale at the Hackney Nursery, Adelaide, 1845. In *The Adelaide Observer*, Saturday 3 May 1845, pp. 1–2. Available at <https://trove.nla.gov.au/newspaper/page/18834521> [Verified 11 September 2018]
- Bean AR (2007) A new system for determining which plant species are indigenous in Australia. *Australian Systematic Botany* **20**, 1–43. doi:10.1071/SB06030
- Bell KL, Rangan H, Fernandes MM, Kull CA, Murphy DJ (2017) Chance long-distance or human-mediated dispersal? How *Acacia s.l. farnesiana* attained its pan-tropical distribution. *Royal Society Open Science* **4**, 170105. doi:10.1098/rsos.170105
- Bird JTS (1904) The early history of Rockhampton, dealing chiefly with events up till 1870. (The Morning Bulletin: Rockhampton, Qld, Australia) Available at <https://espace.library.uq.edu.au/view/UQ:216457> [Verified 30 January 2019]
- Blainey G, Smith AG (1986) Lewis, Essington (1881–1961). In 'Australian Dictionary of Biography'. (National Centre of Biography, Australian National University, Canberra, ACT, Australia) Available at <http://adb.anu.edu.au/biography/lewis-essington-7185> [Verified 9 May 2019]
- Buckley R (1981) Alien plants in central Australia. *Botanical Journal of the Linnean Society* **82**, 369–379. doi:10.1111/j.1095-8339.1981.tb00968.x
- Burke H, Grimwade G (2013) The historical archaeology of the Chinese in Far North Queensland. *Queensland Archaeological Research* **16**, 121–140. doi:10.25120/qar.16.2013.226
- Burnside D (2018) Buffel grass and Port Hedland. In 'Rangelands Memo', November 2018. p. 38. (Western Australian Department of Primary Industries and Regional Development: Perth, WA, Australia)
- Burrenuck (1932) First fleet cattle. Disaster and its sequel. In *Sydney Morning Herald*, Saturday 13 August 1932, 9. Available at <https://trove.nla.gov.au/newspaper/article/16889435> [Verified 29 January 2019]
- CABI (2013) *Nicotiana glauca* (tree tobacco). In 'CABI Invasive Species Compendium'. Available at <https://www.cabi.org/isc/datasheet/36324> [Verified 15 February 2019]
- CABI (2014) *Sonchus oleraceus* (common sow thistle). In 'CABI Invasive Species Compendium'. Available at <https://www.cabi.org/ISC/datasheet/50584> [Verified 1 February 2019]
- CABI (2017a) *Conyza bonariensis* (hairy fleabane). In 'CABI Invasive Species Compendium'. Available at <https://www.cabi.org/isc/datasheet/15250> [Verified 5 June 2017]
- CABI (2017b) *Pennisetum setaceum* (fountain grass). In 'CABI Invasive Species Compendium'. Available at <https://www.cabi.org/isc/datasheet/116202> [Verified 29 May 2017]
- CABI (2017c) *Opuntia aurantiaca* (jointed cactus). In 'CABI Invasive Species Compendium'. Available at <https://www.cabi.org/isc/datasheet/37708> [Verified 22 March 2017]
- CABI (2017d) *Ricinus communis* (castor bean). In 'CABI Invasive Species Compendium'. Available at <https://www.cabi.org/isc/datasheet/47618> [Verified 16 March 2017]
- CABI (2017e) *Opuntia stricta* (erect prickly pear). In 'CABI Invasive Species Compendium'. Available at <https://www.cabi.org/isc/datasheet/37728> [Verified 22 March 2017]
- CABI (2019a) *Chloris virgata* (feather finger grass). In 'CABI Invasive Species Compendium'. Available at <https://www.cabi.org/isc/datasheet/113265> [Verified 11 February 2019]
- CABI (2019b) *Dichanthium annulatum* (Kleberg's bluestem). In 'CABI Invasive Species Compendium'. Available at <https://www.cabi.org/isc/datasheet/113873> [Verified 14 February 2019]
- CABI (2019c) *Solanum nigrum* (black nightshade). In 'CABI Invasive Species Compendium'. Available at <https://www.cabi.org/isc/datasheet/50540> [Verified 22 May 2019]
- CABI (2019d) *Tribulus terrestris* (puncture vine). In 'CABI Invasive Species Compendium'. Available at <https://www.cabi.org/isc/datasheet/54447> [Verified 20 November 2019]
- Caley P, Groves RH, Barker R (2008) Estimating the invasion success of introduced plants. *Diversity & Distributions* **14**, 196–203. doi:10.1111/j.1472-4642.2007.00440.x
- Campbell MA, King BJ, Allworth MB (2014) The southern Australian beef industry. In 'Beef Cattle Production and Trade'. (Eds L Kahn, D Cottle) Chapter 10, pp. 185–204. (CSIRO Publishing: Melbourne, Vic., Australia).
- Carew J (1934) Noogoora burr. *Agricultural Gazette of New South Wales* **45**, 546
- Cook GD, Dias L (2006) It was no accident: deliberate plant introductions by Australian government agencies during the 20th century. *Australian Journal of Botany* **54**, 601–625. doi:10.1071/BT05157
- Council of Heads of Australasian Herbaria (2017) Australian plant collectors and illustrators: 1780s–1980s. (Australian National Herbarium) Available at <http://www.cpbr.gov.au/bot-biog/index.html> [Verified 8 May 2019]
- CRC for Australian Weed Management (2003a) Prickly acacia (*Acacia nilotica*). Available at <https://www.environment.gov.au/biodiversity/invasive/weeds/publications/guidelines/wons/pubs/a-nilotica.pdf> [Verified 20 February 2019]
- CRC for Australian Weed Management (2003b) Athel pine or tamarisk (*Tamarix aphylla*). Available at <https://www.environment.gov.au/biodiversity/invasive/weeds/publications/guidelines/wons/pubs/t-aphylla.pdf> [Verified 10 May 2019]
- Csurhes S (2016) 'Invasive Plant Risk Assessment: Giant Reed *Arundo donax*.' (Queensland Government: Brisbane, Qld, Australia)
- Dane F, Liu J (2007) Diversity and origin of cultivated and citron type watermelon (*Citrullus lanatus*). *Genetic Resources and Crop Evolution* **54**, 1255–1265. doi:10.1007/s10722-006-9107-3
- Dane F, Liu J, Zhang C (2007) Phylogeography of the bitter apple, *Citrullus colocynthis*. *Genetic Resources and Crop Evolution* **54**, 327–336. doi:10.1007/s10722-005-4897-2
- Department of Agriculture, Water and the Environment (2020a) Outback Australia – the rangelands. Available at <https://www.environment.gov.au/land/rangelands> [Verified 12 February 2020]
- Department of Agriculture, Water and the Environment (2020b) Changes to Australia's biosecurity system. Available at <https://www.agriculture.gov.au/biosecurity/australia/biosecurity-reform> [Verified 23 May 2020]
- Department of Natural Resources, Mines and Energy (2004) 'Prickly Acacia: National Case Studies Manual. Approaches to the Management of Prickly Acacia (*Acacia nilotica* subsp. *indica*) in Australia.' (Department of Natural Resources, Mines and Energy, Queensland: Brisbane, Qld, Australia)
- Dunbar KR, Facelli JM (1999) The impact of a novel invasive species, *Orbea variegata* (African carrion flower), on the chenopod shrublands of South Australia. *Journal of Arid Environments* **41**, 37–48. doi:10.1006/jare.1998.0471
- Everist SL (1976) Parthenium weed. *Queensland Agricultural Journal* **102**, 2
- Flinders Ranges Research (2019) Eureka. Available at <https://www.southaustralianhistory.com.au/eureka.htm> [Verified 8 February 2019]
- Flora NT (2013) *Sorghum almum* Parodi. Available at <http://eflora.nt.gov.au/factsheet?id=4768> [Verified 23 May 2020]
- Forages T (2016) *Cenchrus pennisetiformis*. Available at [http://www.tropicalforages.info/key/forages/Media/Html/entities/cenchrus\\_pennisetiformis.htm](http://www.tropicalforages.info/key/forages/Media/Html/entities/cenchrus_pennisetiformis.htm) [Verified 15 November 2016]
- Forages T (2017a) *Cynodon dactylon*. Available at [http://www.tropicalforages.info/key/forages/Media/Html/entities/cynodon\\_dactylon.htm](http://www.tropicalforages.info/key/forages/Media/Html/entities/cynodon_dactylon.htm) [Verified 14 February 2019]
- Forages T (2017b) *Dichanthium annulatum*. Available at [http://www.tropicalforages.info/key/forages/Media/Html/entities/dichanthium\\_annulatum.htm](http://www.tropicalforages.info/key/forages/Media/Html/entities/dichanthium_annulatum.htm) [Verified 15 February 2019]

- Forages T (2018) *Sorghum* × *almum*. Available at [http://www.tropicalforages.info/key/forages/Media/Html/entities/sorghum\\_perennial.htm](http://www.tropicalforages.info/key/forages/Media/Html/entities/sorghum_perennial.htm) [Verified 25 September 2018]
- Gardner CA (1930) The double gee. *Emex australis* Steinh. In *Western Mail*, Thursday 6 November 1930, p. 43. Available at <https://trove.nla.gov.au/newspaper/article/38518956> [Verified 11 September 2018]
- Gilbert LA (1972) Dietrich, Amalie (1821–1891). In 'Australian Dictionary of Biography'. (National Centre of Biography, Australian National University, Canberra, ACT, Australia) Available at <http://adb.anu.edu.au/biography/dietrich-amalie-3412> [Verified 8 May 2019]
- Giles E (1889) 'Australia Twice Traversed, Vol. 1.' (Low, Marston, Searle and Rivington: London, UK) [Facsimile printed in 1979 by Macarthur Press (Books): Sydney, NSW, Australia]
- Grice AC (2002) The biology of Australian weeds 39. *Ziziphus mauritiana* Lam. *Plant Protection Quarterly* **17**, 2–11.
- Groves RH (1999) Sleeper weeds. In 'Papers and Proceedings of the 12th Australian Weeds Conference', September 1999, Hobart, Tas., Australia. (Eds AC Bishop, M Boersma, D Barnes) pp. 632–636. (Tasmanian Weed Society: Devonport, Tas., Australia)
- Groves RH, Boden R, Lonsdale M (2005) 'Jumping the garden fence: invasive garden plants in Australia and their environmental and agricultural impacts.' (WWF-Australia: Sydney, NSW, Australia)
- Hall TJ (1978) Cloncurry buffel grass (*Cenchrus pennisetiformis*) in north-western Queensland. *Tropical Grasslands* **12**, 10–19.
- Hardie J (1981) 'Nor' Westers of the Pilbara breed.' (Shire of Port Hedland: Port Hedland, WA, Australia)
- Haseler WH (1976) *Parthenium hysterophorus* L. in Australia. *PANS* **22**, 515–517. doi:10.1080/09670877609414342
- Hawkins JA, Boutaoui N, Cheung KY, van Klinken RD, Hughes CE (2007) Intercontinental dispersal prior to human translocation revealed in a cryptogenic invasive tree. *New Phytologist* **175**, 575–587. doi:10.1111/j.1469-8137.2007.02125.x
- Hill AJ (1979) Birdwood, William Riddell (Baron Birdwood) (1865–1951). In 'Australian Dictionary of Biography'. (National Centre of Biography, Australian National University, Canberra, ACT, Australia) Available at <http://adb.anu.edu.au/biography/birdwood-william-riddell-baron-birdwood-5240> [Verified 26 February 2019]
- Hocking PJ, Liddle MJ (1986) The biology of Australian weeds: 15. *Xanthium occidentale* Bertol. complex and *Xanthium spinosum* L. *Journal of the Australian Institute of Agricultural Science* **52**, 191–221.
- Hoddinott WG (1967) Milligan, Joseph (1807–1884). In 'Australian Dictionary of Biography'. (National Centre of Biography, Australian National University, Canberra, ACT, Australia) Available at <http://adb.anu.edu.au/biography/milligan-joseph-2456> [Verified 29 April 2019]
- Hodges P (2014) 'North East Pastoral NRM District Weed Strategy.' (South Australian Arid Lands Natural Resources Management Board: Port Augusta, SA, Australia)
- Holtze M (1887) List of useful plants grown in the Government Botanical Garden at Port Darwin. In 'Government Resident's Report on Northern Territory for the Year 1887.' pp. 33–40. (Government Printer: Adelaide, SA, Australia)
- Holtze M (1892) Introduced plants in the Northern Territory. *Transactions and Proceedings and Report of the Royal Society of South Australia* **15**, 1–4.
- Hosking JR, McFadyen RE, Murray ND (1988) Distribution and biological control of cactus species in eastern Australia. *Plant Protection Quarterly* **3**, 115–123.
- Hudson P (1985) The naturalisation of *Stapelia variegata* L. (Asclepiadaceae) at Whyalla, South Australia. *South Australian Naturalist* **60**, 32–34.
- Humphreys LR (1967) Buffel grass (*Cenchrus ciliaris*) in Australia. *Tropical Grasslands* **1**, 123–134.
- Johnson RW (1995) The aliens have landed: an account of the development of the naturalised flora of Queensland. *Proceedings of the Royal Society of Queensland* **105**, 5–17.
- Jones P (2007) Notes on Lieutenant Herbert Dittrich (f. 1880s). (Australian National Herbarium) Available at <https://www.anbg.gov.au/biography/dittrich-herbert.html> [Verified 13 February 2019]
- Keighery G (2010) The naturalised vascular plants of the Pilbara region, Western Australia. *Records of the Western Australian Museum* **78**, 299–311. doi:10.18195/issn.0313-122x.78(1).2010.299-311
- Kellermann J (2007) Re-instatement of the name *Spyridium waterhousei* from Kangaroo Island, South Australia, with a short history of the tribe Pomaderreae (Rhamnaceae). *Journal of the Adelaide Botanic Gardens* **21**, 55–62.
- Kimber RG (1997) Buffel grass: camel drivers main suspects. In *Centralian Advocate*, Friday 26 September 1997, p. 45.
- King C (2005) Tackling weeds on private land initiative. Stakeholder analysis: garden industry e-commerce and mail order segment report. Department of Primary Industries, Catchment and Agricultural Services, Melbourne, Vic., Australia.
- King PG (1803) Governor King to Lord Hobart. *Historical Records of Australia, Series 1* **4**, 233–239.
- Kloot PM (1983) Early records of alien plants naturalised in South Australia. *Journal of the Adelaide Botanic Gardens* **6**, 93–131.
- Kloot PM (1987a) The naturalised flora of South Australia 2. Its development through time. *Journal of the Adelaide Botanic Gardens* **10**, 91–98.
- Kloot PM (1987b) The naturalised flora of South Australia 3. Its origin, introduction, distribution, growth forms and significance. *Journal of the Adelaide Botanic Gardens* **10**, 99–111.
- Kloot PM (1987c) The naturalised flora of South Australia 4. Its manner of introduction. *Journal of the Adelaide Botanic Gardens* **10**, 223–240.
- Kodala PG, Tindale ND (2001) 'Flora of Australia. Vol. 11A–11B Mimosaceae, *Acacia*, Subg. 1. *Acacia*.' pp. 196–207. (Australian Government Publishing Service: Canberra, ACT, Australia)
- Lawson B, Bryant M, Franks A (2004) Assessing the potential distribution of buffel grass (*Cenchrus ciliaris* L.) in Australia using a climate-soil model. *Plant Protection Quarterly* **19**, 155–163.
- Leichhardt L (1847) 'Journal of an Overland Expedition in Australia, from Moreton Bay to Port Essington, a Distance of Upwards of Some 3000 Miles, During the Years 1844–1845.' (T.W. Boone: London, UK) [Facsimile edition. First published 1847, printed by Macarthur Press (Books): Sydney, NSW, Australia]
- Lindsay D (1889) An expedition across Australia from south to north, between the telegraph line and the Queensland boundary, in 1885–6. *Proceedings of the Royal Geographical Society and Monthly Record of Geography* **11**(11), 650–671. doi:10.2307/1801028
- Lindsay G, Lindsay HA (1952) Across Australia in 1886 [An account by George Lindsay, aged eighteen, of a trip with a camel team led by his uncle David Lindsay, from Dalhousie Station to Lake Nash, with an introduction and comments by H.A. Lindsay, George Lindsay's son]. *Proceedings of the Royal Geographical Society of Australasia, South Australian Branch* **54**, 35–41.
- Lonsdale WM (1994) Inviting trouble – introduced pasture species in northern Australia. *Australian Journal of Ecology* **19**, 345–354. doi:10.1111/j.1442-9993.1994.tb00498.x
- Mackey AP (1997) The biology of Australian weeds 29. *Acacia nilotica* ssp. *indica* (Benth.) Brenan. *Plant Protection Quarterly* **12**, 7–17.
- Macpherson A (1894) Red Natal grass. In *Brisbane Courier*, Friday 13 July 1894, p. 2. Available at <http://nla.gov.au/nla.news-article3583515> [Verified 20 June 2017]
- Maiden JH (1895) The 'saffron' – or 'false star thistle' (*Kentrophyllum lanatum*, D.C. et Dub.). *Agricultural Gazette of New South Wales* **5**, 298–300.
- Maiden JH (1911a) The prickly pears of interest to Australians. *Agricultural Gazette of New South Wales* **22**, 696–698.
- Maiden JH (1911b) The prickly pears of interest to Australians. *Agricultural Gazette of New South Wales* **22**, 321–328.

- Maiden JH (1914) Australian vegetation. In 'Federal Handbook, 84th Meeting British Association for the Advancement of Science, Chapter 5'. (Ed CH Knibbs) pp. 163–209. (Government Printer: Melbourne, Vic., Australia)
- Maiden JH (1920) 'The Weeds of New South Wales. Part 1.' (Government Printer: Sydney, NSW, Australia)
- Manly Council (2019) Manly heritage and history. Available at <http://www.manlycouncil.info/council/about-manly/manly-heritage-history/index.html> [Verified 29 January 2019]
- Mann J (1970) 'Cacti Naturalised in Australia and their Control.' (Government Printer: Brisbane, Qld, Australia)
- Marriott SJ (1955) Buffel grass. *Journal of the Australian Institute of Agricultural Science* **21**, 277–278.
- Marsden S (1991) A short history of Kangaroo Island. In 'Professional Historians Australia (SA)'. Available at <http://www.sahistorians.org.au/175/documents/susan-marsden-a-short-history-of-kangaroo-island.shtml> [Verified 24 September 2018]
- McDonald J, Paterson A, Anderson R (2019) Rock art shows early contact with US whalers on Australia's remote northwest coast. In *The Conversation*, 19 February 2019. Available at <https://theconversation.com/rock-art-shows-early-contact-with-us-whalers-on-australias-remote-northwest-coast-104931> [Verified 10 April 2019]
- McEwen G (1842) Catalogue of Plants Introduced by and Cultivated in the Garden of Mr Stevenson, North Adelaide. In *South Australian Register*, Saturday 23 April 1842, p. 3. Available at <http://nla.gov.au/nla.news-article27443323> [Verified 4 July 2017]
- McKnight TL (1969) 'The Camel in Australia.' (Melbourne University Press: Melbourne, Vic., Australia)
- McLaren DA (2008) Historical aspects of commercial weed invasions – perennial grass case studies. *Plant Protection Quarterly* **23**, 65–69.
- Meadly GRW (1971) Calotropis, or rubber tree (*Calotropis procera* (Linn.) Dryand). *Journal of Agriculture Western Australia* **12**, 69–71.
- Michael PW (1981) Alien plants. In 'Australian Vegetation'. (Ed. RH Groves) pp. 44–64. (Cambridge University Press: Cambridge, UK)
- Miller AG, Morris M (1988) 'Plants of Dhofar: the Southern Region of Oman: Traditional, Economic and Medicinal Uses.' (Office of the Advisor for Conservation of the Environment, Diwan of Royal Court, Sultanate of Oman: Muscat, Oman)
- Millington RW, Squires VR (1980) A screening of selected pasture species for the floodplains of central Australia. Technical Memorandum 80/4. CSIRO Division of Land Resources Management, Perth, WA, Australia.
- Moran VC, Annecke DP (1979) Critical reviews of biological pest control in South Africa. 3. The jointed cactus, *Opuntia aurantiaca* Lindley. *Journal of the Entomological Society of Southern Africa* **42**, 299–329.
- Morris D (1974) Mueller, Sir Ferdinand Jakob Heinrich von (1825–1896). In 'Australian Dictionary of Biography'. (National Centre of Biography, Australian National University, Canberra, ACT, Australia) Available at <http://adb.anu.edu.au/biography/mueller-sir-ferdinand-jakob-heinrich-von-4266> [Verified 1 September 2018]
- Morrison SM, Scott JK (1996a) Variation in populations of *Tribulus terrestris* (Zygophyllaceae), 2. Chromosome numbers. *Australian Journal of Botany* **44**, 191–199. doi:10.1071/BT9960191
- Morrison SM, Scott JK (1996b) Variation in populations of *Tribulus terrestris* (Zygophyllaceae), 3. Isozyme analysis. *Australian Journal of Botany* **44**, 201–212. doi:10.1071/BT9960201
- Navie SC, McFadyen RE, Panetta FD, Adkins SW (1996) The biology of Australian weeds 27. *Parthenium hysterophorus* L. *Plant Protection Quarterly* **11**, 76–88.
- Noack D (1994) Date palms and the exotic flora of Dalhousie Springs. *South Australian Geographical Journal* **93**, 81–89.
- Novoa A, Le Roux JJ, Robertson MP, Wilson JRU, Richardson DM (2015) Introduced and invasive cactus species: a global review. *AoB Plants* **7**(1), plu078. doi:10.1093/aobpla/plu078
- NSW WeedWise (2014) Columbus grass (*Sorghum × alnum*). Available at <https://weeds.dpi.nsw.gov.au/Weeds/ColumbusGrass> [Verified 24 May 2020]
- Nunn WM, Suijendorp H (1954) Kapok bush (*Aerva tomentosa*). A very useful perennial for north-west pastoral areas. *Journal of Agriculture Western Australia* **3**(6), 741–743.
- O'Keefe M (1966) Archer, Charles (1813–1862). In 'Australian Dictionary of Biography'. (National Centre of Biography, Australian National University, Canberra, ACT, Australia) Available at <http://adb.anu.edu.au/biography/archer-charles-1712> [Verified 5 September 2016]
- Parsons WT, Cuthbertson EG (2001) 'Noxious Weeds of Australia', 2nd edn. (CSIRO Publishing: Melbourne, Vic., Australia)
- Pearson M, Lennon J (2010) Chapter 1, Genesis 1788–1830. In 'Pastoral Australia: Fortunes, Failures and Hard Yakka'. (Eds M Pearson, J Lennon) pp. 3–18. (CSIRO Publishing: Melbourne, Vic., Australia)
- Peirce JR (1992) The biology of Australian weeds 23. *Carthamus lanatus* L. *Plant Protection Quarterly* **7**, 86–95.
- Perry TM (1966) Cunningham, Allan (1791–1839). In 'Australian Dictionary of Biography'. (National Centre of Biography, Australian National University, Canberra, ACT, Australia) Available at <http://adb.anu.edu.au/biography/cunningham-allan-1941> [Verified 1 September 2018]
- Petheram RJ, Kok B (2003) 'Plants of the Kimberley Region of Western Australia.' (University of Western Australia: Perth, WA, Australia)
- Primary Industries and Regions SA (2017) History of agriculture in SA. Available at <http://www.pir.sa.gov.au/aghistory/industries/livestock> [Verified 25 January 2019]
- Project Gutenberg Australia (2014) North Australian expedition 1855–6. Available at <http://gutenberg.net.au/ebooks14/1402621h.html#ch-08> [Verified 14 February 2019]
- Quinn G, Andrew HW (1915) A new weed. *Journal of the Department of Agriculture of South Australia* **19**, 380–383.
- Richardson DM, Pyšek P, Rejmánek M, Barbour MG, Panetta FD, West CJ (2000) Naturalization and invasion of alien plants: concepts and definitions. *Diversity & Distributions* **6**, 93–107. doi:10.1046/j.1472-4642.2000.00083.x
- Robinson TW (1965) Introduction, spread and areal extent of saltcedar (*Tamarix*) in the western states. US Geological Survey Professional Paper 491-A. (US Government Printing Office: Washington, DC, USA) Available at <https://pubs.usgs.gov/pp/0491a/report.pdf> [Verified 30 May 2020]
- Scherer PA (1993) 'Sunset of an Era. The Heffernans of Ti-Tree.' (National Library of Australia: Canberra, ACT, Australia)
- Scott JK, Friedel MH, Grice AC, Webber BL (2018) Weeds in Australian arid regions. In 'On the Ecology of Australia's Arid Zone'. (Ed. H Lambers) pp. 307–330. (Springer: Cham, Switzerland). doi:10.1007/978-3-319-93943-8
- Shafroth PB, Cleverly JR, Dudley TL, Taylor JP, van Ripper C III, Weeks EP, Stuart JN (2005) Control of *Tamarix* in the western United States: implications for water salvage, wildlife use, and riparian restoration. *Environmental Management* **35**, 231–246. doi:10.1007/s00267-004-0099-5
- Shaik RS, Gopurenko D, Urwin NAR, Burrows GE, Lepschi BJ, Weston LA (2015) Population genetics of invasive *Citrullus lanatus*, *Citrullus colocynthis* and *Cucumis myriocarpus* (Cucurbitaceae) in Australia: inferences based on chloroplast and nuclear gene sequencing. *Biological Invasions* **17**, 2475–2490. doi:10.1007/s10530-015-0891-6
- Squires VR (1979) The biology of Australian weeds 1. *Tribulus terrestris* L. *Journal of the Australian Institute of Agricultural Science* **45**, 75–82.
- Steele W, Steele C (1978) 'To the Great Gulf. The Surveys and Explorations of L.A. Wells, Last Australian Explorer 1869–1838'. (Lynton: Adelaide, SA, Australia)

- Steenkamp PA, van Heerden FR, van Wyk B-E (2002) Accidental fatal poisoning by *Nicotiana glauca*: identification of anabasine by high performance liquid chromatography/photodiode array/mass spectrometry. *Forensic Science International* **127**, 208–217. doi:10.1016/S0379-0738(02)00123-8
- Stevens C (1989) 'Tin Mosques and Ghantowns: a History of Afghan Cameleers in Australia.' (Oxford University Press: Melbourne, Vic., Australia)
- Stokes CA, MacDonald GE, Adams CR, Langeland KA, Miller DL (2011) Seed biology and ecology of natalgrass (*Melinis repens*). *Weed Science* **59**, 527–532. doi:10.1614/WS-D-11-00028.1
- Strehlow J (2011) 'The Story of Frieda Keysser. Vol. 1. 1875–1910.' (Wild Cat Press: London, UK)
- Tanner L (2015) Prickly pear history – Part 1. In 'North West Weeds'. Available at <http://www.northwestweeds.com.au/prickly-pear-history-nsw/> [Verified 22 March 2017]
- Turner F (1912) Cape spinach. An obnoxious plant. In *Sydney Morning Herald*, Saturday 7 December 1912, p. 7. Available at <https://trove.nla.gov.au/newspaper/article/15381257> [Verified 11/9/2018]
- von Klinken RD, Campbell SD (2009) *Prosopis* L. species. In 'The Biology of Australian Weeds. Vol. 3'. (Ed. FD Panetta) pp. 238–273. (RG & FJ Richardson: Melbourne, Vic., Australia)
- von Klinken RD, Campbell SD, Heard TA, McKenzie J, March N (2009) The biology of Australian weeds 54. *Parkinsonia aculeata* L. *Plant Protection Quarterly* **24**, 100–117.
- von Klinken RD, Panetta FD, Coutts S, Simon B (2015) Learning from the past to predict the future: an historical analysis of grass invasions in northern Australia. *Biological Invasions* **17**, 565–579. doi:10.1007/s10530-014-0749-3
- von Mueller F (1876) 'Select Plants Readily Eligible for Industrial Culture or Naturalisation in Victoria with Indications of their Native Countries and Some of Their Uses.' (Government of Victoria and M'Carron, Bird & Co.: Melbourne, Vic., Australia)
- Warburton PE (1875) 'Journey Across the Western Interior of Australia.' (Sampson Low, Marston, Low, & Searle: London, UK)
- Waterson DB (1972) Gregory, Francis Thomas (Frank) (1821–1888). In 'Australian Dictionary of Biography'. (National Centre of Biography, Australian National University, Canberra, ACT, Australia) Available at <http://adb.anu.edu.au/biography/gregory-francis-thomas-frank-3899> [Verified 1 February 2019]
- Watson KA (1979) Control of *Parthenium hysterophorus* with Picloram and 2,4-D in central Queensland. In 'Proceedings 7th Annual Asian–Pacific Weed Science Society Conference', 26–30 November 1979, Sydney, NSW, Australia. pp. 133–136. (Council of Australian Weed Science Societies: Sydney, NSW, Australia)
- Webber BL, Yeoh PB, Scott JK (2014) Invasive *Passiflora foetida* in the Kimberley and Pilbara: understanding the threat and exploring solutions. Phase 1 final report. (CSIRO Australia). Available at <https://library.dbca.wa.gov.au/static/FullTextFiles/071853.pdf> [Verified 16 April 2019]
- White-Haney J (1930) Noogoora burr in Queensland. *Journal Council for Scientific and Industrial Research (Australia)* **3**, 77–82.
- Wikipedia (2016) Pandanus Creek battery. Available at [https://en.wikipedia.org/wiki/Pandanus\\_Creek\\_Battery](https://en.wikipedia.org/wiki/Pandanus_Creek_Battery) [Verified 2 December 2016]
- Wikipedia (2017) Victoria River (Northern Territory). Available at [https://en.wikipedia.org/wiki/Victoria\\_River\\_\(Northern\\_Territory\)](https://en.wikipedia.org/wiki/Victoria_River_(Northern_Territory)) [Verified 23 June 2017]
- Wikipedia (2019a) *Senna occidentalis*. Available at [https://en.wikipedia.org/wiki/Senna\\_occidentalis](https://en.wikipedia.org/wiki/Senna_occidentalis) [Verified 1 February 2019]
- Wikipedia (2019b) Cooktown, Queensland. Available at [https://en.wikipedia.org/wiki/Cooktown,\\_Queensland](https://en.wikipedia.org/wiki/Cooktown,_Queensland) [Verified 1 February 2019]
- Wikipedia (2019c) *Solanum nigrum*. Available at [https://en.wikipedia.org/wiki/Solanum\\_nigrum](https://en.wikipedia.org/wiki/Solanum_nigrum) [Verified 8 May 2019]
- Wikipedia (2019d) *Vachellia farnesiana*. Available at [https://en.wikipedia.org/wiki/Vachellia\\_farnesiana](https://en.wikipedia.org/wiki/Vachellia_farnesiana) [Verified 17 May 2019]
- Wikipedia (2019e) Forrest River massacre. Available at [https://en.wikipedia.org/wiki/Forrest\\_River\\_massacre](https://en.wikipedia.org/wiki/Forrest_River_massacre) [Verified 28 February 2019]
- Willis JH (1961) Botanical science in Victoria 100 years ago. *Proceedings of the Royal Society of Victoria, New Series* **73**, 41–45. doi:10.1023/A:1016695609745
- Wu H (2007) The biology of Australian weeds 49. *Conyza bonariensis* (L.) Cronquist. *Plant Protection Quarterly* **22**, 122–131.
- Wu H, Shepherd A, Asaduzzaman M, Broster J (2016) Can herbicides affect seed dormancy and viability of flaxleaf fleabane (*Conyza bonariensis* (L.) Cronquist). In 'Proceedings of the 20th Australasian weeds conference', 11–15 September 2016, Perth, WA, Australia. (Eds R Randall, S Lloyd, C Borger), pp. 128–132. (Weeds Society of Western Australia: Perth, WA, Australia)
- Yan X, Li Z, Gregg WP, Li D (2001) Invasive species in China – an overview. *Biodiversity and Conservation* **10**, 1317–1341. doi:10.1023/A:1016695609745

Handling editor: Lynda Prior

### Appendix 1. Common names, countries of origin and historical records of 54 introduced invasive plants in arid Australia

ADB, Australian Dictionary of Biography (<http://adb.anu.edu.au>, accessed 24 May 2020); ALA, Atlas of Living Australia (<https://www.ala.org.au/>, accessed 24 May 2020); APNI, Australian Plant Name Index (<https://www.anbg.gov.au/apni/>, accessed 24 May 2020); AVH, Australasia's Virtual Herbarium, (<http://avh.chah.org.au/>, accessed 24 May 2020); CABI, Centre for Agriculture and Biosciences International, Invasive Species Compendium (<https://www.cabi.org/isc>, accessed 24 May 2020); Flora of Pakistan (<http://www.tropicos.org/Project/Pakistan>, accessed 24 May 2020); JSTOR, Global Plants on JSTOR (<https://plants.jstor.org/>, accessed 24 May 2020); Lucid (<https://keyserver.lucidcentral.org/weeds/data/media/Html/>, accessed 24 May 2020); NSW WeedWise (<https://weeds.dpi.nsw.gov.au>, accessed 24 May 2020); Tropical Forages (<http://www.tropicalforages.info/key/forages/Media/Html/entities/index.html>, accessed 24 May 2020); Weed CRC, CRC for Australian Weed Management (<https://www.environment.gov.au/biodiversity/publications/#weeds>, accessed 24 May 2020)

Species	Common name(s)	Native to	Earliest reports of introduction—see text for further detail
<i>Accidental introduction</i>			
<i>Acetosa vesicaria</i> (L.) A.Löve	Ruby dock, rosy dock, wild hops	North Africa, south-west Asia, Indian subcontinent (Lucid)	1892 Perth, WA (AVH); 1904 Peterborough, SA (AVH); 1909 Kalgoorlie, WA (AVH); 1913 Mt Morgans, WA (AVH); 1916 North Adelaide, SA (cultivated) (AVH)
<i>Aerva javanica</i> (Burm.f.) Juss. ex Schult.	Kapok bush	Africa, Arabian Peninsula, southern Asia, Indian subcontinent (Lucid)	1880s Western Australia (Petheram and Kok 2003); 1937 de Grey River, WA (AVH); 1938 Roy Hill Station, WA (AVH)
<i>Alternanthera pungens</i> Kunth	Khaki weed	South America (Lucid); tropical America (Parsons and Cuthbertson 2001)	1898 NSW (Parsons and Cuthbertson 2001); 1910 Qld (Parsons and Cuthbertson 2001)
<i>Argemone ochroleuca</i> Sweet subsp. <i>ochroleuca</i>	Mexican poppy	Mexico (Parsons and Cuthbertson 2001)	1844 Sydney Cove, 1845 George Street Sydney, NSW (Maiden 1920, Parsons and Cuthbertson 2001) [possibly <i>A. mexicana</i> ]; 1885 Brisbane, Qld (Bailey 1885); 1886 Junction of Nepean and Warragamba Rivers, NSW (AVH); 1887 Port Darwin Botanical Garden, NT (Holzle 1887) [probably <i>A. mexicana</i> ]
<i>Calotropis procera</i> (Aiton) R.Br. ex W.T. Aiton	Rubber bush, calotrope	North-west Africa, Middle East to Pakistan and India (Parsons and Cuthbertson 2001)	1935 Mungana, Qld (AVH); [earlier records may be <i>C. gigantea</i> ]
<i>Carrichtera annua</i> (L.) DC.	Ward's weed	Mediterranean region and western Asia (Lucid)	c. 1913 Port Pirie, SA (Quinn and Andrew 1915); 1915 Port Pirie, SA (AVH)
<i>Carthamus lanatus</i> L.	False star thistle, saffron thistle	Southern Europe and Mediterranean region (Lucid)	1803 Sydney, NSW (King 1803; Parsons and Cuthbertson 2001) [but see Kloot 1983; possibly <i>C. trictorius</i> ]; 1872 Stawell, Vic. (AVH)
<i>Cenchrus echinatus</i> L.	Mossman River grass	Tropical America (Parsons and Cuthbertson 2001)	Qld 1860s? (Parsons and Cuthbertson 2001); 1901 Townsville, Qld (AVH)
<i>Chloris virgata</i> Sw.	Feathertop Rhodes grass, feather finger grass	Africa, Asia (including India and Pakistan), North America, central America, the Caribbean and tropical South America (Lucid)	1875 MacDonnell Ranges East, near Alice Springs, NT (AVH); 1879 Hermannsburg Mission, Finke River, NT (AVH); 1880 Barrow Creek, NT (AVH); 1882 Peake, Chandler Range, NT (AVH); 1885 south of Charlotte Waters, NT (AVH)
<i>Citrullus colocynthis</i> (L.) Schrad.	Colocynth	Northern Africa to western Asia (Parsons and Cuthbertson 2001)	1887 Port Darwin Botanical Garden, NT – 'colocynth', medicine (Holzle 1887); 1923 Townsville, Qld (AVH)
<i>Citrullus lanatus</i> (Thunb.) Matsum. & Nakai	Camel melon, Afghan melon, pie melon	Africa, predominantly southern (Dane and Liu 2007)	1836 Kangaroo Island, SA (Parsons and Cuthbertson 2001); 1845 Tasmania (Parsons and Cuthbertson 2001); 1866 Rockhampton, Qld (AVH)
<i>Conyza bonariensis</i> (L.) Cronquist	Flax leaf, hairy fleabane	South America (Wu <i>et al.</i> 2016; CABI 2017a)	1842 Telligerry Creek, NSW (AVH); 1848 Adelaide, St Vincent's Gulf, SA (Kloot 1983)
<i>Cucumis myriocarpus</i> Naudin	Prickly paddy melon	Southern Africa (Parsons and Cuthbertson 2001) via stepping-stone country (Shaik <i>et al.</i> 2015)	1847 Torrens River, SA (Kloot 1983); 1851 Torrens River, SA (AVH)

(continued next page)

## Appendix 1. (continued)

Species	Common name(s)	Native to	Earliest reports of introduction—see text for further detail
<i>Eragrostis barrelieri</i> Daveau	Pitted love grass	Pakistan, Mediterranean region to the Middle East, tropical Africa (Flora of Pakistan)	1883 and 1888 Depot Creek-Mt Parry, SA (AVH); 1896 Alice Springs, NT (AVH); 1898 Mt Lyndhurst, SA (AVH)
<i>Eragrostis ciliaris</i> (All.) Vignolo ex Janch.	Stink grass	Europe, Africa, Arabian Peninsula, Western Asia, Indian sub-continent and Eastern Asia (Lucid)	1885 Manly, NSW (AVH); 1899 Dubbo, Mudgee, NSW (AVH)
<i>Eragrostis minor</i> Host	Little love grass, little stink grass	Pakistan, warm temperate and sub-tropical regions of Old World (Flora of Pakistan)	1907 Rockhampton, Qld (AVH); 1908 Jericho, Qld (AVH); 1909 Duaringa, Qld (AVH)
<i>Eragrostis trichophora</i> Coss. & Durieu; also known as <i>E. cylindriflora</i> Hochst.	Hairy (flower) love grass, curly leaf	Northern and southern Africa, tropical Arabia (APNI, JSTOR)	1971 Alice Springs, NT (AVH)
<i>Neurada procumbens</i> L.	Neurada	North Africa, Middle East to north-west India (Albrecht <i>et al.</i> 2002)	2000 150 km SE Alice Springs, NT (Albrecht <i>et al.</i> 2002)
<i>Parthenium hysterophorus</i> L.	Parthenium weed	Subtropics of North and South America (Weed CRC)	1950 Toogoolawah, Qld (AVH); 1964 Clermont, Qld (AVH)
<i>Passiflora foetida</i> L.	Stinking passion flower	Southern United States of America, Caribbean, Mexico, central and South America (Lucid)	1854 Sydney flower show (Anon. 1854); 1875 'In gardens of Queensland' (AVH); 1882 Cooktown, Qld (AVH); c. 1882 Fannie Bay [Darwin], NT (Holtze 1892)
<i>Senna occidentalis</i> (L.) Link	Coffee senna	Tropical and subtropical regions of the Americas (Lucid)	1883 Cooktown, Qld (AVH); 1885 Brisbane Botanic Garden, Qld (Bailey 1885); 1891 Walsh Electric Telegraph Station or vicinity [200 km west of Cairns], Qld (AVH)
<i>Solanum nigrum</i> L.	Blackberry nightshade, black nightshade	North-western Africa, Europe, western and central Asia, China and northern India, Nepal and Pakistan (CABI 2019c; Lucid)	1847 Flinders Island, Tas. (AVH); 1848 Norwood, SA (AVH); 1850 Adelaide Hills, SA (AVH); 1861 Kangaroo Island (Klout 1983, Kellermann 2007)
<i>Sonchus oleraceus</i> L.	Milk thistle, common sow thistle	Europe, Northern Africa, western Asia (CABI 2014)	1838 Fremantle (AVH); 1844 [vicinity of Mt Nicholson State Forest], Qld (Leichhardt 1847); 1847 already a weed, Adelaide, SA (Klout 1983)
<i>Tribulus terrestris</i> L. (non-native)	Caltrop, puncture vine	Mediterranean (Squires 1979; CABI 2019d)	1853 Murray River, Vic. and NSW (AVH); [native?] 1856 Gilbert River, Qld (AVH); 1869 near Packsaddle, NSW (AVH); 1863 (?1861) Nickol Bay, WA (AVH)]
<i>Vachellia farnesiana</i> (L.) Wight & Arn	Mimosa bush, yellow mimosa	Tropical regions of the Americas (Lucid)	Pre-1788 (Kodala and Tindale 2001; Bean 2007); 1818 Exmouth Gulf-Cossack (Perry 1966, Bean 2007); 1843 Condamine plains, Qld (AVH); 1847 Dawson River, Qld (AVH); 1856 Sturt's Creek WA, Arnhem Land NT, Albert River [near Burketown] Qld (AVH)
<i>Xanthium occidentale</i> Bertol.	Noogoora burr	Southern United States of America, Mexico and West Indies (Hocking and Liddle 1986)	1850s Noogoora Station, floodplain of Brisbane River, 16 km from Ipswich, Qld (Carew 1934; Hocking and Liddle 1986); 1885 Brisbane Botanic Garden, Qld (Bailey 1885)
<i>Xanthium spinosum</i> L.	Bathurst burr	South America, probably Valparaiso, Chile, (Hocking and Liddle 1986; Parsons and Cuthbertson 2001)	c. 1830 Twofold Bay, NSW (Maiden 1920; Hocking and Liddle 1986), 1830s Nepean River, NSW, observed by John Macarthur (Parsons and Cuthbertson 2001); pre-1862 South Australia (Klout 1987a)
Accidental and intentional introduction <i>Cenchrus ciliaris</i> L.	Buffel grass	Africa, Asia incl. Afghanistan, Pakistan and north-west India (Tropical Forages)	1887 Kimberley district, WA (AVH); 1920s Tea Tree Well, NT (Scherer 1993); 1920s Mundabullangana Station, WA (Hardie 1981); 1931 Woodforde Well, NT (AVH); 1932 Botanic Gardens Sydney, NSW (AVH); 1932 Towera Station, WA (AVH)

(continued next page)



## Appendix I. (continued)

Species	Common name(s)	Native to	Earliest reports of introduction—see text for further detail
<i>Cenchrus pennisetiformis</i> Hochst. & Steud.	Cloncurry buffel	Africa, Asia (including India and Pakistan) (Tropical Forages 2016)	1915 Geraldton-Greenough, WA (AVH); 1922 Port Hedland, WA (AVH); 1930 Tea Tree Well, NT (AVH); 1931 Cloncurry, Qld (AVH)
<i>Cenchrus setaceus</i> (Forssk.) Morrone	Fountain grass	Northern and eastern Africa, south-western Asia to Syria (Lucid)	1903 Eureka (Orroroo), SA (AVH); 1930 Brisbane, Qld (AVH); 1931 Strathfield, NSW (AVH); 1931 vicinity of Fremantle, WA (AVH)
<i>Cynodon dactylon</i> (L.) Pers.	Couch grass	Probably sub-Saharan Africa or islands in western Indian Ocean (Lucid)	Likely pre-1788 (Lucid); 1843 Mr. MacKenzie's flat [Kilcoy], near Brisbane, Qld (AVH); 1845 Singleton, NSW (AVH); 1848 Port Adelaide, SA (AVH)
<i>Dichanthium annulatum</i> (Forssk.) Stapf	Sheda grass, Kleberg's bluestem	Africa, Arabian Peninsula, western Asia, the Indian subcontinent and south-east Asia (Myanmar, Thailand, Indonesia, Malaysia and Papua New Guinea) (Lucid)	1856 Depot Creek, head of Victoria River [(Dagaragu), NT (AVH)
<i>Emex australis</i> Steinh.	Spiny emex, doublegee	Southern Africa (Parsons and Cuthbertson 2001)	1830 Swan River settlement, WA (Turner 1912); c. 1840 SA (Parsons and Cuthbertson 2001); 1848 Adelaide, SA (AVH)
As <i>Mimosa nilotica</i> L.	Prickly acacia	<i>V. nilotica</i> subsp. <i>indica</i> is native to drier areas of Africa, Pakistan and India (Mackey 1997)	As <i>M. nilotica</i> , 1803 Sydney, NSW (King 1803)
As <i>Acacia arabica</i> subsp. <i>indica</i> (Benth.) Brennan			As <i>A. arabica</i> , 1845 available in J. Bailey's nursery, Adelaide, SA (Bailey 1845); 1887 Port Darwin Botanical Garden, NT (Holtze 1887)
As <i>Acacia nilotica</i> subsp. <i>indica</i> (Benth.) Brennan.			As <i>A. nilotica</i> , 1845 available in J. Bailey's nursery, Adelaide, SA (Bailey 1845); 1874 Nickol Bay near Karratha, WA (AVH)
As <i>Vachellia nilotica</i> subsp. <i>indica</i> (Benth.) Kyal. & Boatwr.			As <i>V. nilotica</i> subsp. <i>indica</i> , 1883 cultivated at Port Denison, Qld (AVH)
Intentional introduction			
<i>Arundo donax</i> L.	Giant reed	Contentious (Csurhes 2016)	1845 available in J. Bailey's nursery, Adelaide, SA (Bailey 1845); 1885 Brisbane Botanic Garden, Qld (Bailey 1885); 1894 Gosford, NSW (not cultivated) (AVH); 1912 Qld, first planting (Csurhes 2016)
<i>Asphodelus fistulosus</i> L.	Onion weed	Mediterranean to western Asia and northern India (Parsons and Cuthbertson 2001)	1857 Melbourne Botanic Gardens, Vic. (Parsons and Cuthbertson 2001); 1858 Adelaide Botanic Garden, SA (Parsons and Cuthbertson 2001)
Cactaceae examples			
<i>Cylindropuntia fulgida</i> var. <i>mamillata</i> (A. Schott ex Engelm.) Backeb.	Coral cactus, boxing glove cactus	Ecuador and Peru (Hodges 2014)	1911 NSW (Maiden 1911a); 1934 Quirindi, NSW (AVH)
<i>Cylindropuntia imbricata</i> (Haw.) F.M.Knuth	Devil's rope, rope pear	Southern United States of America and Mexico (Hodges 2014)	1883 NSW (Parsons and Cuthbertson 2001); 'many years' before 1911, near Goondiwindi, Qld (Maiden 1911b); 1906 Windsor and Agnes Banks, NSW (Maiden 1911b)
<i>Opuntia aurantiaca</i> Lindl.	Tiger pear, jointed cactus	Northern Argentina, Paraguay and Uruguay (Lucid)	Pre-1839 Sydney, NSW (Parsons and Cuthbertson 2001)
<i>Opuntia stricta</i> (Haw.) Haw.	Common prickly pear, erect prickly pear	Drier tropical and subtropical Americas (Hodges 2014; CABI 2017e)	1920s Introduced to Mundabullangana Station, WA (Hardie 1981); 1932 Roebourne, WA (introduced) (AVH); 1933 Canberra, ACT (cultivated) (AVH); 1933–38 Townsville roadsides and beachfront, Qld (not cultivated) (AVH)
<i>Cenchrus setiger</i> Vahl	Birdwood grass	Afghanistan (Humphreys 1967); East Africa and India (Petheram and Kok 2003)	

(continued next page)

Appendix 1. (continued)

Species	Common name(s)	Native to	Earliest reports of introduction—see text for further detail
<i>Melinis repens</i> (Willd.) Zizka	Red Natal grass	Canary Islands, Africa, Seychelles, Arabian Peninsula and India (Lucid)	1876 Brisbane, Qld, via Adelaide Botanic Garden, SA (Bailey 1910); 1894 Lismore, NSW (AVH)
<i>Nicotiana glauca</i> Graham	Wild tobacco, mustard tree, tree tobacco	Central north-west Argentina and Bolivia (CABI 2013)	c. 1847 Adelaide, SA, introduced by Mr FM Dutton (Klout 1983); 1850 Torrens River, SA (AVH)
<i>Orbea variegata</i> (L.) Haw.	Carrión flower, starfish flower	South Africa – Cape Province (Lucid)	1967 Whyalla, SA (AVH); 1969 Wallumbilla, Qld (AVH)
<i>Parkinsonia aculeata</i> L.	Parkinsonia	Southern United States of America, Caribbean, Mexico and northern South America (Parsons and Cuthbertson 2001; Hawkins <i>et al.</i> 2007)	1860s central Qld proposed by van Klimken <i>et al.</i> (2009); 1885 Brisbane Botanic Garden, Qld (Bailey 1885); 1894 Melbourne Botanic Gardens, Vic. (AVH); 1901 Sydney Botanic Garden, NSW (AVH)
<i>Phoenix dactylifera</i> L.	Date palm	Obscure, probably northern Africa, Arabian Peninsula and north-west India (ALA)	1845 available in J Bailey's nursery, Adelaide, SA (Bailey 1845); 1856 'Captain Wickham's garden, Newstead', Qld (Bailey 1910); 1867 Brisbane Botanic Garden, Qld (Bailey 1910); 1890 Pilbara, WA (Keighery 2010), 1890s Dalhousie, NT (Noack 1994)
Mesquites	Mesquite, prosopis	Unknown	1886 Unidentified <i>Prosopis</i> sp. collected north of MacDonnell Ranges, enroute to Lake Nash, NT (AVH)
<i>Prosopis glandulosa</i> Torr. var. <i>glandulosa</i>	Mesquite, prosopis, honey mesquite	Southern United States of America and Mexico (Lucid)	1885 cultivated Brisbane Botanic Garden, Qld (Bailey 1885); 1935 first non-cultivated record Millmerran, Qld (AVH)
<i>Prosopis juliflora</i> Sw. (DC.)	Mesquite, prosopis	Mexico, Central and northern South America (Lucid), and Caribbean (Wikipedia)	1877 cultivated Brisbane Botanic Garden, Qld (brought from Honolulu) (Bailey 1910); 1962 first non-cultivated record far north SA (AVH)
<i>Prosopis pallida</i> (Willd.) Kunth <i>Prosopis velutina</i> Wootton	Mesquite Velvet mesquite, black mesquite	North-western parts of South America (Lucid) South-western United States of America and northern Mexico (Lucid)	1936 de Grey Station Homestead, WA (AVH) 1899 cultivated Sydney Botanic Gardens, NSW (AVH); 1957 first non-cultivated record Comongin near Quilpie, Qld (AVH)
<i>Ricinus communis</i> L.	Castor oil plant, Palma Christi, castor bean	North-eastern Africa (Ethiopia and Somalia), but widely cultivated for as long as 6000 years (CABI 2017d)	1803 Sydney, NSW, as 'Palma Christi' (King 1803); 1841 old Adelaide Botanic Garden, SA (Bailey 1841); 1861 Brisbane Botanic Garden, Qld (Bailey 1910); pre-1891 Darwin, NT (Holtze 1892)
<i>Sorghum x almum</i> Parodi	Columbus grass	Argentina, Chile, Peru and Uruguay (NSW WeedWise 2014). Natural hybrid arising from cultivated and weedy sorghum in Argentina (Tropical Forages 2018)	1953 Rockhampton Downs, NT (AVH); 1954 Biloela, Qld (AVH); 1963 Wilcannia, NSW (cultivated?) (AVH); 1965 Everard Park, SA (AVH); 1983 Uluru, NT (used in soil conservation works) (AVH)
<i>Tamarix aphylla</i> (L.) H.K.arsr	Athel pine, tamarisk	Northern and eastern Africa, the Middle East, south-western Asia and the Indian subcontinent (Lucid)	c. 1930 Whyalla, SA and 1936 Broken Hill, NSW (Parsons and Cuthbertson 2001); 1953 Paroo, Qld (AVH); 1969 Cobar, NSW (AVH)
<i>Ziziphus mauritiana</i> Lam.	Chinee apple	Eastern Africa and southern Asia (Grice 2002)	pre-1842 Adelaide, SA, as <i>Ziziphus jujuba</i> (McEwen 1842); 1863 Torres Strait Islands (Parsons and Cuthbertson 2001); pre-1864 Brisbane Botanic Garden, Qld (Bailey 1910); 1886 Etheridge River, Qld (AVH); pre-1891 Darwin, NT (Holtze 1892)