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THE NATURALISED FLORA OF SOUTH AUSTRALIA 4. ITS MANNER OF INTRODUCTION

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Abstract

Many species of the present naturalised alien flora of South Australia were introduced intentionally for ornamental, culinary, medicinal, fodder, hedge and other purposes. The paper discusses these uses. Unintentional introductions occurred through contaminated seed, ballast, fleece, footwear, fodder and packing material. The scant documentation of those processes in South Australia that has been located, is presented. The roles and consequences of intentional and accidental introductions are discussed and compared.

Introduction

The species comprising the naturalised alien flora of South Australia (Kloot, 1986a) have been introduced both intentionally and accidentally since the first European contact in 1802 (Kloot, 1985b). The summarised results of the analyses of the available data (Kloot, 1986b) revealed that the majority of the naturalised flora had been introduced intentionally mainly as ornamentals. Other uses were as fodder and culinary plants and to a lesser extent as hedges and medicinals.

Local evidence for unintentional introductions is scarce. The main manner of introduction was in contaminated seed but other means included contaminated ballast and fodder and attached to stock. Overseas literature suggest that this last reason is more important than our records demonstrate.

In this paper, these methods of introduction are examined further, compared and discussed.

Intentional introductions

That a plant was recorded elsewhere as an ornamental, hedge plant, medicinal etc. (e.g. Loudon, 1830), is not proof that it was introduced for that purpose to South Australia. Furthermore, even when a plant was recommended to be grown in South Australia, e.g. Heyne (1871), this also is not proof that it actually was grown here for that purpose. Similarly, that certain plants were recorded as seed-contaminants or wool-adventives (e.g. Hayward and Druce, 1919; Probst, 1949) is evidence that such plants are capable of spreading by these means, but cannot be taken, by itself, as proof that this was the means by which they were introduced to South Australia. Nevertheless, plants listed by Loudon (1830) as ornamentals may be sought successfully in local nurserymen's catalogues. Many of Schomburgk's (1885) recommendations for medicinal herbs were actually listed as growing in the Adelaide Botanic Garden a few years later (*J. Bur. Agric.* 1: 18-19). Other local documentation (e.g. Stevenson, 1839; McEwin, 1841 *et seq.*, 1843a; Bailey, 1845; Francis, 1859; Schomburgk 1871, 1878) refers to local experience of the respective authors and may be cited confidently as evidence.

The following sections deal with a number of specific uses for which plants were imported. Particular emphasis has been given to plants being introduced for purposes considered no longer fashionable, useful or effective.

Ornamentals

Of the thousands of plants that were introduced to South Australia as ornamentals, 359

are now part of the naturalised flora (Kloot, 1986b). They are too numerous to be considered individually, but two groups in particular that have waned in popularity since the last century are "ornamental grasses" and "curiosities".

Ornamental grasses

Last century the cultivation of ornamental grasses was very fashionable both overseas (e.g. Delamer, 1865) and locally (e.g. Heyne, 1871; Hackett, 1876). The term "grass" was used somewhat loosely to include other monocotyledonous plants, particularly Cyperaceae. Of the presently naturalised grasses, 18 species and 7 generic groups (e.g. "*Agrostis*", "*Chloris*") are known to have been promoted and sold in South Australia last century. They include *Aira caryophylla* (Anon., 1879), *Avena fatua* (Anon., 1879), *Avena sterilis* (Heyne, 1871), *Briza maxima* (McEwin, 1843; Heyne, 1871), *Briza minor* (Heyne, 1871), *Cenchrus echinatus* = *C. longispinus* (Pascoe, 1886), *Cyperus* — "many kinds" (Heyne, 1871), *Digitaria ciliaris* (Pascoe, 1886), *Eragrostis megastachya* = *E. cilianensis* (Anon., 1879) and *Vulpia bromoides* (Pascoe, 1886).

Curiosities

The Victorian era was one of great scientific curiosity (Barber, 1980), and gardeners cultivated interesting or "curious" plants from all over the world. Loudon (1830) listed many plants cultivated in Britain as "curiosities" as distinct from "ornamentals". This interest was also found amongst early Australian gardeners. Thus Hackett (1876) advertised gourds as being "curious and beautiful". Of presently established plants, 39 species were noted by Loudon (1830) as being grown in Britain as "curiosities" at that time, although little local evidence is available. They include *Avena sterilis*, *Cyperus tenellus*, *Echinochloa crus-galli*, *Euphorbia terracina*, *Medicago* spp., *Onopordum acaulon*, *Peganum harmala*, *Silene apetala*, and *Sporobolus indicus* = *S. africanus*.

Culinary plants

A number of presently naturalised plants were introduced to South Australia for culinary purposes. As a result of changed eating habits, the following are no longer, or at least rarely, used as such.

Calendula officinalis — Pot marigold, a pot herb (McEwin, 1843), but introduced even earlier (Bailey, 1841).

Cichorium intybus — Chicory although sown as a fodder plant (Capper, 1838), was also used by the earliest settlers as a coffee substitute (Stevenson, 1839).

Cynara cardunculus — Cardoon or chardon, a salad vegetable (Stevenson, 1839). The use of the flowers as a substitute for "Scotch thistles" (Parsons, 1973) arose fortuitously, advantage being taken of their wide availability in the absence of the true Scotch thistle (*Onopordum acanthium*).

Cyperus rotundus — in error for *C. esculentus*, groundnut or chuffa (Kloot, 1979).

Mesembryanthemum crystallinum — Iceplant, although originally introduced as an ornamental (Kloot 1983) it was recommended locally to be grown as a substitute for spinach (Heyne, 1871).

Nasturtium officinale — Watercress.

Opuntia spp. — Prickly pear. Specifically included with fruit trees (McEwin, 1843).

Physalis peruviana — Cape gooseberry.

Physalis viscosa — Sticky cape gooseberry.

Rumex acetosella — Garden sorrel (*R. acetosa*) was an early introduction as a garden vegetable (Stevenson, 1839) and noted as being grown very commonly soon after (Bailey, 1847). I suggest that the present species was introduced in error and/or as a contaminant of the garden sorrel.

Tragopogon porrifolius — Salsify or oyster plant.

Tropaeolum majus — Greater Indian cress, a pot herb (McEwin, 1843) now known as garden nasturtium. Recorded as flowering in the old Botanic Garden in 1841 (Bailey, 1841).

Medicinal herbs

The cultivation of many herbs in home gardens for medicinal use was considered desirable, if not essential. Many culinary herbs were also used medicinally so they have been included here also. Extant references to the cultivation of herbs show that they were very early introductions (Stevenson, 1839; McEwin, 1843; Bailey, 1847). Schomburgk (1885) recommended 38 species of medicinal plants which, from their success in the Botanic Gardens, he believed should be grown more widely. Of those that he listed, the following species are now naturalised in South Australia:

Achillea millefolium — Yarrow.

Cichorium intybus — Chicory.

Cytisus scoparium =
Sarothamnus scoparius — Common English broom.

Foeniculum vulgare — Fennel.

Lavandula spica = *L. dentata* — Lavender.

Leontodon taraxacum = *Taraxacum officinale* — Dandelion.

Marrubium vulgare — Horehound.

Melissa officinalis — Lemon balm.

Mentha pulegium — Pennyroyal.

Mentha piperita — Peppermint.

Mentha viridis = *M. spicata* — Spearmint.

Rosmarinus officinalis — Rosemary.

Thymus vulgaris — Thyme.

Verbascum thapsus — Broad-leafed mullein.

A slightly later listing of herb plants growing in the Adelaide Botanic Garden in January-February, 1889 (*J. Bur. Agric.* 1: 18-19) adds:

Anthemis nobilis = *Chamaemelum nobile* — Chamomile (common).

Poterium sanguisorba = *Sanguisorba minor* — Sheep's burnet.

Withania coagulans = *S. somnifera* — Winter cherry.

Hedge Plants

Away from the stringybark forests of the higher rainfall areas, timber suitable for fencing was generally scarce in South Australia. Consequently hedges were planted as paddock and property boundaries, apart from a general attempt to recreate the hedgerowed scenery of the English countryside.

Hedge-growing was largely abandoned and while most of the hedges were removed or died out, remnants survived and, through neglect, spread into surrounding pastures and bushland, particularly in the high rainfall areas where most of the former hedge species are more aggressive. *Lycium ferocissimum* was a notable exception, being the most invasive of the abandoned hedge plants. Its berries were spread by birds and now it is found from the wettest pockets of the Adelaide Hills to the flood plains of the rivers in the interior. It was of such concern that this species was subject to its own Act of Parliament, the Boxthorn Removal Act, 1925. In contrast, hedges of *Agave americana* have hardly spread during a century.

Each of the following species, presently naturalised in South Australia, is known to have been promoted and used for hedges in this State last century:

Acacia armata = *A. paradoxa* (McEwin, 1843a)

Agave americana (1858 — *Farm & Garden*, 1: 59)

Aloe arborescens

Arundo donax

Crataegus azarolus

Crataegus monogyna (1858 — *Farm & Garden*, 1: 3, as white thorn)

Genista canariensis = *G. maderensis* (Heyne, 1871)

Cytisus scoparius = *Sarothamnus scoparius* (1859 — *Farm & Garden*, 1: 199)

Hakea eucalyptoides = *H. laurina* (Heyne, 1871)

Lycium afrum } = *L. ferocissimum* (Heyne, 1871)

Lycium horridum }

Lycium barbarum

Olea europaea (1862 — *Farm & Garden*, 5: 51)

Opuntia spp. (McEwin, 1843a)

Pittosporum undulatum (Heyne, 1871)

Polygala myrtifolia (Heyne, 1871)

Rhamnus alaternus (Heyne, 1871)

Rosa canina (1858 — *Farm & Garden*, 1: 10)

Rosa rubiginosa ("The Observer", 30 March 1844, p. 4)

Rosmarinus officinalis (1858 — *Farm & Garden*, 1: 189)

Spartium junceum (1858 — *Farm & Garden*, 1: 109)

Ulex europaeus (1860 — *Farm & Garden*, 2: 129)

Fodder plants

Many species of alien plants have been documented as being distributed, intentionally sown or encouraged for fodder at various times and places in South Australia. A species may not have been introduced for that purpose necessarily but many plants were tried, perhaps in desperation, as the native flora disappeared under the close grazing of introduced ruminants and the perennial pasture species of northern Europe and Britain known from the settlers'

homelands viz. *Lolium perenne* and *Trifolium repens*, failed to persist in the short growing seasons of South Australia. The adoption of annual ryegrass (*Lolium* spp.), subterranean clover (*T. subterraneum*) and medics (*Medicago* spp.) largely obviated the necessity for the wide range of species tried in the past. All such species are listed in Appendix 1 with selected references, including the earliest located, to illustrate their use as fodder.

Sundry agricultural uses

The major remaining use is that of "sandbinding" or erosion control. A number of plants were recommended and used for that purpose, including many that were used for fodder, particularly on sandhills. A few species were grown in the belief that they kept away crop predators. Representative references, including the earliest located for the specified use are cited in Appendix 2.

Unintentional introductions

The means of accidental introduction, whilst clear in principle, are very rarely documented in practice. Locally, I am unaware of any studies of ballast heaps, contaminated footwear or carriage on animals. Some anecdotal references of varying reliability are available. The most extensive documentation exists for seed contamination, as seed testing records indicate the contaminants found. As with intentional introductions, it is rarely possible to be certain that any particular means of entry was the source of present infestations. For example, *Bromus unioloides* is documented as being first introduced by Taylor in 1857, who bulked up the seed and sold it commercially in 1858 (*Farm & Garden* 1: 7). However, Mueller had collected weedy forms of the same species in 1848 (Kloot, 1983).

The following records are available, suggesting possible means of entry.

Contaminated seed

This is a particularly effective means of introduction for should a weed be successful enough to reproduce and contaminate the crop with which it is competing, then it is likely to be able to succeed again, when the contaminated seed is moved and sown elsewhere.

Although it may be assumed that agricultural and horticultural seeds would have been contaminated and agricultural implements brought by farmers from England would also have carried propagules (Letter from H. Duncan "S.A. Register" - 4.iv.1840), there are no records as to what they might have been. It is reasonable to assume that seeds brought from Britain would contain weeds recorded there. Loudon (1835) lists the following weeds as infesting the English cereal sample at that time — *Lolium temulentum*, *Agrostemma githago*, *Ervum tetrasperum* (= *Vivia tetrasperma*), *Melilotus officinalis*, *Avena fatua*, *Galium aparine*, *Scandix pectens* (= *S. pecten-veneris*), *Polygonum convolvulus*, *Polygonum lapathifolium*, *Sinapis*, *Brassica* and *Raphanus*. Some of these weeds became established very early in South Australia (Kloot, 1983). *Avena fatua* was noted as a contaminant of the original seed wheat introduced to South Australia (*Farm & Garden* 1: 38). *Silene gallica* and *Agrostemma githago* were further grain contaminants from the very early days (Kloot, 1983). The former was still recorded as a contaminant of wheat seed in 1893 (*J. Bur. Agr.* 6: 110).

Dittrichia graveolens was probably introduced to Australia in contaminated wheat imported from Germany sown in the Adelaide Hills about 1863 (W.C. Grassby, quoted by Maiden, 1920). *Ambrosia psilostachya* was introduced from North America in contaminated *Sorghum* seed (A. Jericho, *in litt.* attached to AD 97417250). The parasites, *Cuscuta* spp. are notorious as seed contaminants, and would have entered Australia by that means.

After the introduction of quarantine regulations in 1908, the testing of imported seed for disease and contamination was instituted. Andrew (1916, 1917) presented results from the first

years of seed testing in South Australia. He concluded that "the chief medium through which new weed pests have been introduced into various countries is by way of agricultural and other seed". He was particularly concerned with seed intended for sowing but he was also alarmed at the contamination of other seed, particularly bird feed.

Praeger (1911) highlighted the potency of contaminated seed as a means of weed introduction to Clare Island, Co. Mayo, Eire. Prior to 1907, farmers had only locally purchased agricultural seeds, but then began to use higher quality seed brought from the Irish and English mainlands. Commercial seed available on the Island was sampled in 1910 and many weeds not previously recorded there were found as contaminants.

Broad (1953) and Wellington (1960) provide extensive listings of weed species found in pasture seed examined in Great Britain. Whilst these lists are not directly relevant to South Australia, they are still useful indicators of the extent of contamination of seed in the agricultural trade prior to the advent of present seed-cleaning equipment and the adoption of modern weed control methods. Many of our present naturalised species are listed there.

Ballast weeds

There was a long local history of ships arriving in South Australian ports under ballast. This practice continued until after World War II, when the grain ketches ceased operating from the various outports, being superseded by centralised terminals serviced by land transport (Heinrich, 1976). There are many instances of ballast being dumped but I do not believe that any botanical records of such sites exist. Certain plants are believed to be ballast plants — *Diplotaxis tenuifolia*, *Galenia pubescens*, *Reseda lutea* and *Sida leprosa*, on the basis of annotations to locally collected specimens and comments by earlier authors. The distribution of some species suggests a ballast origin, e.g. *Suaeda aegyptiaca* in the saline flats at Port Pirie, *Euphorbia paralias* on the foreshore of Yorke Peninsula and adjacent coasts, and *Chenopodium multifidum* which since its first discovery in 1911 has only been found at three ports, Tumby Bay, Wallaroo and Port Adelaide. Although contaminated ballast was likely to have been a powerful influence on the alien flora, Ridley's (1930) statement that the species described by Black (1909) were "all probably introduced in ships' ballast" is an exaggeration.

Tovey (1911) noted a number of plants found around a ballast dump on Coode Island in the Port of Melbourne. Some of his species could have also been introduced in a similar manner to South Australia.

A number of lists of plants found on ballast heaps overseas last century are available: Martindale (1876, 1877) for Philadelphia and Perkins (1883) for Boston in the U.S.A., and Kirk (1896) for Wellington, New Zealand. More recently Ouren (1979) has investigated some of the former ballast dumps of Norway. Although it is many years since they were in use, many plants are clearly recognised as having been associated with the dumps. Soil and sand used for ballast were known to be a source of weeds and in some places such material was required to be dumped at sea to minimise weed invasion (Ridley, 1930). All the cited lists contain many species now naturalised in South Australia. It is reasonable to assume that ballast dumped in those places would have been similar in origin and contained similar weed propagules to that dumped locally. In particular, strand plants or ruderals found in the vicinity of ports would be most likely to be found in ballast.

Some species that were recorded overseas as ballast plants were not recorded until much later in South Australia, so that it is unlikely that their entry was through that means. For example, *Potentilla reptans* was recorded by Martindale (1876, 1877) but it was not known locally until 1967, well after the ballast period. Its congener *P. anserina*, also listed by Martindale, was first recorded in South Australia in 1882, within the period of ballast dumping.

Contaminated footwear

There is little doubt that plant propagules are carried in mud attached to footwear (Praeger, 1911; Clifford, 1956) but apart from the cited papers, no other studies were located. These authors were concerned with such movement within the British Isles, but it is reasonable to assume that the same species, probably in lesser numbers and less frequently, could have arrived in South Australia in the same manner. It is quite likely that other species recorded as introduced intentionally were also introduced on footwear, e.g. *Anthoxanthum odoratum* and *Bromus hordeaceus* in South Australia may be derived from accidentally introduced propagules on footwear (Praeger, *op. cit.*) rather than from intentional introductions for fodder (Appendix 1).

Attached to stock

Plant propagules encased in fruits or attached to stalks which adhere by spines or bristles e.g. *Echium plantagineum*, are likely to be moved attached to fleeces and coats of animals (e.g. van der Pijl, 1982). There are very few empirical data to support this classification. Shmida and Ellner (1983) report the only experimental study of seed dispersal on grazing animals in a Mediterranean environment and their observations include some of our naturalised species. Milthorpe (1943) investigated the vegetable matter in the New South Wales wool clip at that time and Church (1947) surveyed the wool clip from a wider area of south-eastern Australia, including South Australia. Most of the species found were Australian natives, but many aliens were also present.

Although such species were clearly being carried in fleeces at that period, that is not conclusive proof that they were introduced to South Australia or Australia generally, in that manner. Hayward and Druce (1917) and Probst (1949) have indicated an even wider range of species that might be carried by such means by listing the "wool-aliens" i.e. the plants introduced to northern England and Central Europe respectively in wool for processing, although it must be allowed that more propagules are likely to be successfully transported in baled fleeces rather than on live animals which would tend to shed plant fragments during the voyage.

Locally, *Xanthium spinosum* was introduced in the fleeces of animals brought from New South Wales (S.A. Parl. Paper (205/1862) as were *X. occidentale* and *X. orientale* in recent years (Pest Plant Commission records). *Chloris truncata* was spread to the southern parts of South Australia by movement in contaminated fleeces (Kloot, 1985a). It was also recorded as a wool alien by all four cited authors.

Contaminated fodder

As with seed intended for sowing, fodder such as hay, feed grains, and chaff may contain weed propagules. During drought, even low-quality, contaminated produce finds a ready market. It is noticeable that imports of hay and chaff peaked during drought years and a number of weeds were first recorded in the aftermath of drought e.g. *Solanum elaeagnifolium* in 1914, *Pentzia suffruticosa* in 1922. Apart from introduction *per se*, weeds greatly extend their distribution during droughts being moved around in fodder (Thomas *et al.*, 1984). They are then well-placed to take advantage of subsequent favourable seasons.

Emex australis was introduced in fodder from South Africa about 1840 (The Advertiser, 19.xii.1934) as was *Cyperus tenellus* (Kloot, 1979). *Carthamus lanatus* could also have been introduced in contaminated fodder having first been observed in an area where travelling bullock teams camped (S.A. Parl. Paper No. 102/1887).

Contaminated packing material

Straw was a common packing material around bottles and other fragile articles and was

also used as stuffing for saddles, mattresses and so on. *Scirpus hamulosus* and *Cenchrus ciliaris* were both specifically noted (as annotations to herbarium sheets of early specimens) as originating from stuffing in camel saddles. *Carrichtera annua* (Quinn and Andrew, 1915) and *Cirsium arvense* (*J. Bur. Agr.* 1: 5) both originated in dumped straw packing that had protected goods imported from Europe and Victoria respectively. It was noted that dried grasses and other growths from the vicinity of nurseries were used for packing around plants sent from the eastern colonies around the turn of the century. Portions of weeds including seed heads were often found (*J. Agric. S.A.* 2: 968).

These uses are now very uncommon and consequently their importance as a means of introduction of alien plants is now negligible.

Motor vehicles

In more recent years, larger-spined propagules were, and still are carried about on car tyres. Although the introduction of *Tribulus terrestris* preceded the invention of motor cars, it was carried on vehicle tyres throughout the Adelaide metropolitan area (Walker and Parker, 1941). More recently, *Alternanthera pungens* was introduced by vehicles from New South Wales and its progress from one caravan park to the next westward from the border areas has been quite obvious (C.R. Alcock, pers. comm.).

Motor vehicles are efficient carriers of plant propagules (Wace, 1977 *et seq.*) and the long distances traversed by individual vehicles in this country will result in a greater distribution of naturalised species.

Intentional and accidental introductions

Whether a plant was introduced accidentally or on purpose can only be expressed in a context defined both in time and space. It is not possible in many cases to state categorically that a given species was introduced one way or another. Furthermore, there are many examples where more than one type of introduction was involved. For example, *Digitaria sanguinalis* was introduced accidentally at various times but it was also introduced intentionally to the Adelaide Botanic Garden as a potential fodder grass in 1880 (Schomburgk, 1881). *Agrostemma githago* was first introduced as a contaminant of seed grains but failed to persist and was introduced again later as an ornamental (Kloot, 1983). *Trifolium repens* was introduced and sown by the earliest settlers as a fodder plant (Capper, 1838) but it was reported as having been introduced accidentally as a contaminant of seed wheat brought from Tasmania some years later (*Farm & Garden* 1: 207).

As regards space it is necessary to define the area being considered. There are many examples of plants being introduced intentionally to South Australia as a whole or to a specific locality within it, but once established there spreading unaided to a greater or lesser extent. Some examples are *Echium plantagineum*, *Oxalis pes-caprae* and *Adonis microcarpus*. Each of these species was introduced as an ornamental and moved around the State as such (primary spread). After introduction to suitable habitats each species spread unaided or with unintentional human aid to cover varying areas of the settled areas of the State (secondary spread).

Another situation is where a plant has different histories in different places. Certain pasture plants are good examples. *Trifolium subterraneum* seems to have been introduced accidentally to South Australia and subsequently became established in the Adelaide Hills. However, following its promotion as a pasture legume, it was sown deliberately over vast areas of south-eastern Australia. *Lolium rigidum* was similarly introduced accidentally although there is a record that a higher yielding form was introduced intentionally from Europe (Mullet, 1919). Within southern Australia both desirable and weedy forms were sown widely from the mid-1920s and like *T. subterraneum* it still is being sown as an annual pasture plant.

A related situation occurred where certain plants native to restricted areas of Australia were moved, intentionally or otherwise, to other regions and became established there. For example, *Cyperus rotundus* was moved both intentionally and accidentally from sub-tropical Australia to southern Australia where it became well-established (Kloot, 1979). *Chloris truncata*, rare or even absent from the southern regions of South Australia until the first decade of this century, is now found throughout the State and is particularly common in the Adelaide area. The case of *Eucalyptus cladocalyx* is even more extreme, originally being restricted to three areas in South Australia. Now it is sparingly naturalised over much of south-eastern Australia having spread from its extensive planting as an ornamental and for shelter belts (Kloot, 1985a).

Where plants have been introduced both intentionally and accidentally it is difficult to determine which introduction led to the present infestations. Because of reports of *Echium plantagineum* in seed imports, e.g. Andrew, (1916), Piggin (1977) concluded that accidental introductions were the origin of present populations. However, I rejected this explanation (Kloot, 1982) because more intensive investigations of the literature and herbarium specimens revealed a history consistent with that of a garden escape. In such a case there must be, firstly, a documented history as an ornamental, medicinal, hedge plant, etc. Secondly the records of its spread must suggest that it moved outward from settlements or even from isolated homesteads. Conversely, a seed contaminant tends to be noticed in paddocks quite widely. Thus *Amsinckia calycina* was introduced to the Mallee and Upper South-East in contaminated seed wheat brought from Victoria in the mid-1950s. It was noted in cereal paddocks over a large area in a short period. Similarly, *Solanum elaeagnifolium* although recorded earlier from Victoria (Tovey, 1909), seems to have been introduced to South Australia in hay imported from the U.S.A. during the 1914 drought and was reported from a number of well-scattered sites within a few years.

As a result of property consolidation or the building of new houses, older homestead gardens and orchards were abandoned and the land amalgamated with adjoining paddocks. Cultivation moved bulbs, fruits or other propagules of persistent garden plants about the enlarged paddocks. Subsequently, attached to animals or implements, propagules were carried further afield. This has been documented for *Adonis microcarpus* (Kloot, 1973), and extensive evidence for *Oxalis pes-caprae* was obtained from a survey carried out by the Central Agricultural Bureau in 1898 (*J. Agric. S.A.* 2: 126).

It is incorrect to assess the status of the plant introduced in the past and in particular in the earliest years of settlement on the basis of its benefit or disadvantages as perceived at present. Many plants currently regarded as possessing no redeeming factors were considered desirable or even essential in earlier times.

The failure to establish hedgerows led to a further suite of species being abandoned. More productive fodder species superseded the species that were relied upon formerly. Attempts to create fibre and oilseed industries and a belief that certain plants were vermifuges led to the widespread planting or yet other species that ultimately were unsuccessful for their intended purposes in this country.

There is a further relevant point bearing on plant introduction that has been underestimated. The Victorian age was one of utilitarianism. It was believed that the dawning scientific age would ensure that any latent benefit would be identified, utilised and hopefully turned to economic benefit. Woolls (1867) expressed this feeling most succinctly as follows: ". . . posterity may find out that amongst the weeds of the land which many so unscrupulously condemn, there are some of the marvellous beauties of nature. I believe that God has made nothing in vain and that every species, whether in the animal or vegetable kingdom, has been created for some especial purpose in the economy of nature. If we cannot at present discover these purposes, it is rather owing to our ignorance than to any other cause." As regards native plants, this attitude reached its acme in the publications of Mueller (1876) and Maiden (1889)

who summarised all the available economic information to aid the exploitation of such plants (Mueller's work was wider in scope, also including plants from other temperate areas of the world).

With regard to introduced plants there are many examples of well-meant attempts to turn the apparently wasted resources of an infestation of unwanted plants into an economic crop. Thus Hayter (1861) reported that the woolly pappuses of *Arctotheca calendula* were suitable for making felt hats. Distillation experiments were carried out on *Lavandula stoechas* collected at Finniss to demonstrate to complaining landholders that rather than being a potential weed, it was a new economic opportunity (*J. Bur. Agr.* 5: 137,172). (Ultimately the landholders were right; the distillations were unsuccessful because under South Australian conditions the proportion of volatile oil developed in the plant is too low to extract profitably). Similarly, landholders who drew attention to the weedy potential of *Marrubium vulgare* were rebuked with the information that dried leaves were worth one shilling per pound on the London market (*Ibid.*, 6: 60). The harvesting of *Ricinus communis* was regarded as being suitable for women and children and therefore the cultivation of a few trees on every farm was still being encouraged (Schomburgk, 1881), in spite of the failure and abandonment of the large plantation at Monarto and the general recognition of the weediness of the plant.

Whilst the examples given are well documented, it is highly likely that there were many unrecorded cases of the introduction and/or intentional spread of alien plants which were considered at the time to have some economic potential. I would suggest that *Trifolium* spp. and many grasses would fall into this category. The reasoning is that "clover" *per se* was regarded as beneficial to pastures and that "grasses" were seen similarly as being desirable and therefore to be encouraged. It is noteworthy that most of the pasture species regarded favourably by the British authorities of that time such as Sinclair (1815) and Loudon (1835) have become established in, or at least were introduced to, South Australia.

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Appendix 1

List of alien species with selected references documenting their use as fodder in South Australia

GRAMINEAE

Alopecurus pratensis — meadow foxtail

- 1913 — recommended for sandy country at Monteith. *J. Agric.*, 16: 1193.
1947 — still recommended in pasture mixes. *J. Agric.*, 50: 455.

Anthoxanthum odoratum — sweet vernal grass

- 1925 — recommended *inter alia* for higher rainfall areas. *J. Agric.*, 28: 215.

Arrhenatherum elatius — false oat (grass)

- 1909 — in pasture plots at Saddleworth. *J. Agric.*, 13: 408.

Arundo donax — giant reed

- 1897 — useful for fodder and windbreak *J. Agric.*, 1: 472.
1941 — recommended, *inter alia*, for feed. *J. Agric.*, 45: 75.

Avena fatua — wild oats

- 1891 — so well adapted as a fodder plant that no other species is necessary in Maitland area. *J. Bur. Agr.*, 4: 9, 11.
1892 — seed distributed in the Munderoo area from supply sent from Stansbury. *J. Bur. Agr.*, 4: 223.
— fertilized at Nairne with guano. Hallack (1892) p. 75.

Bromus madritensis — Madrid brome

- 1912 — seen to be thriving in (Adelaide) suburban garden, seeds collected and scattered over newly cleared Mallee country at Nunkeri. *J. Agric.*, 36: 206.

Bromus unioloides — prairie grass

- 1857 — seed introduced by Taylor and bulked up. Seed freely available by summer 1858. *Farm & Garden*, 1:7.

Chloris gayana — Rhodes grass

- 1907 — recommended for fodder. *J. Agric.*, 10: 841.
1911 — sown as fodder at Millicent. *J. Agric.*, 14: 1017.

Cynodon dactylon — couch

- 1928 — *inter alia*, sown in pastures at Yurgo. *J. Agric.*, 32: 147.

Cynosurus echinatus — crested dogstail

1927 — *Inter alia*, trial for pasture at Jamestown. J. Agric., 30: 997.

Dactylis glomerata — cockfoot

1859 — highly recommended as a fodder grass. Francis (1859a).

Echinochloa crus-galli — barnyard grass

1893 — being sown at Naracoorte. J. Bur. Agr., 5:244.

1909 — best fodder on saline areas of reclaimed swamps. J. Agric., 12: 817.

Ehrharta calycina — perennial veldt grass

1908 — "cuttings" (sic,? rhizomes) obtained from South Africa and planted at Kalangadoo. J. Agric., 13: 1119.

1928 — well established at Reeves Plains and Minda Home. J. Agric., 32: 512.

Ehrharta longiflora — annual veldt grass

1930 — included in pasture mixes at Keith. J. Agric., 13: 681.

Elymus repens — quackgrass

1897 — sown as a potential fodder at Crystal Brook. J. Agric., 1: 454.

Festuca arundinacea — Williams Grass, tall fescue

1900 — growing well on Messrs. Williams' property at Millicent and promises to be the best grass to grow on reclaimed swamp land. J. Agric., 3: 1031.

Festuca pratensis — Meadow fescue

1907 — recommended for fodder. J. Agric., 10: 604.

Festuca rubra — red fescue

1894 — sown at Warrow. J. Bur. Agr., 7: 91.

Holcus lanatus — fog grass

1875 — seed distributed and sown throughout State from German supply labelled *Dactylis caespitosa* in error. Schomburgk (1876) p. 4.

1931 — still being sown as fodder at Longwood. J. Agric., 34: 986.

Hordeum? leporinum or? *glaucum* — barley grass

1901 — being deliberately sown for fodder at Craddock. J. Agric., 5: 480.

1912 — seen to be thriving in (Adelaide) suburban garden, seed collected and scattered over newly cleared Mallee country at Nunkeri. J. Agric., 36: 206.

1919 — recommended to be sown at Coonalpyn. J. Agric., 23: 262.

Lolium multiflorum — Italian ryegrass

1906 — recommended for fodder. J. Agric., 10: 480.

Lolium perenne — perennial ryegrass

1906 — recommended for fodder. J. Agric., 10: 480.

Lolium rigidum — Wimmera ryegrass

1919 — recommended to be sown at Coonalpyn. J. Agric., 23: 262.

1922 — combined with sub. clover is good pasture for S.E. J. Agric., 25: 605.

1927 — recommended that wheat should be undersown with it. J. Agric., 31: 174.

Paspalum dilatatum — paspalum

1876 — introduced to Adelaide Botanic Gardens as a potential fodder grass. Schomburgk (1877), p. 4.

1897 — being grown at Lucindale from seeds provided by Botanic Gardens. J. Bur. Agr., 9: 249.

Paspalum vaginatum — salt-water couch

1951 — introduced as a salt-tolerant fodder grass, doing well by 1973. J. Agric., 76: 5.

Pennisetum clandestinum — Kikuyu (grass)

1926 — introduced from Natal and sown as a fodder crop at Mt Remarkable. J. Agric., 30: 56.

1929 — sown on Kybybolite. J. Agric., 36: 409.

Pennisetum villosum — long-styled feather grass

1892 — potentially valuable fodder grass at Tatiara. J. Bur. Agr., 5: 81.

Phalaris aquatica — phalaris

1889 — potential fodder plant growing in Adelaide Botanic Gardens. J. Bur. Agr., 1: 19.

1905 — first sown commercially in S.A. J. Agric., 37: 400.

Phleum pratense — Timothy grass.

1904 — growing at Longwood. J. Agric., 8: 465.

1907 — recommended for fodder. J. Agric., 10: 604.

Piptatherum miliaceum — rice millet.

1908 — sown at Kanmantoo. J. Agric., 12: 71.

1913 — recommended for sandy country at Monteith. J. Agric., 16: 1193.

1914 — for pasture at Geranium. J. Agric., 17: 1219.

Poa annua — winter grass, annual meadow grass.

1912 — "A very hardy grass, affording an early sweet herbage greatly relished by stock. It is a good thing to mix a few pounds of it with other grasses for pasture." Hackett (1912), p. 48.

Poa pratensis — Kentucky blue grass.

1907 — recommended for fodder. J. Agric., 10: 604.

Secale cereale — rye

1899 — being sown at Strathalbyn. J. Agric., 3: 336.

Sorghum halepense — Johnson grass

1875 — doing well at Yankalilla. Highly recommended. Garden & Field, 1: 196.

1899 — sown as fodder at Riverton. J. Agric., 3: 234.

1924 — being sown at Nantawarra. J. Agric., 27: 1002.

Sorghum vulgare — forage sorghum

1858 — highly recommended since that year in S.A. Garden & Field, 1: 40.

1870 — fresh seed obtained from Sydney for Botanic Gardens. Schomburgk (1871a), p. 5.

Stenotaphrum secundatum — buffalo grass1928 — *inter alia* sown in pastures at Yurgo. J. Agric., 32: 147.

BORAGINACEAE

Echium plantagineum — salvation Jane

1918 — desirable plant in North. J. Agric., 21: 884.

CARYOPHYLLACEAE

Silene dichotoma — twobranched catchfly

1897 — potential fodder available from Germany. J. Agric., 1: 47.

Spergula arvensis — (corn) spurry

1897 — well-grown plants from seed sent by the Central Bureau to Naracoorte. J. Bur. Agr., 2: 27.

1898 — distributed to Bureau Branches as potential fodder plant. J. Agric., 1: 362.

COMPOSITAE

Achillea millefolium — yarrow

1896 — weed in garden but good fodder in pasture at Millicent. J. Bur. Agr., 8: 159.

1927 — showing promise (for fodder) at Kybybolite. J. Agric., 29: 1078.

1928 — *inter alia*, sown in pastures at Yurgo. J. Agric., 32: 147.*Arctotheca calendula* — capeweed, (cape) dandelion

1893 — considered desirable at Mt Pleasant. J. Bur. Agr., 6: 79.

1899 — sown for fodder at Mt Gambier. J. Agric., 3: 471.

1907 — good feed, farmers glad to see it. J. Agric., 10: 911.

Cichorium intybus — chicory

1837 — sown at Adelaide for fodder (Capper, 1838).

1934 — recommended as pasture species. J. Agric., 37: 1416.

Cynara cardunculus — artichoke thistle

- 1897 — grown for sheep fodder at Stockport. J. Agric., 1: 163.
 1899 — seed supplied to Craddock Bureau as a good fodder. J. Agric., 3: 52.
 1920 — being sold as a drought resistant fodder. J. Agric., 24: 4.

Dittrichia graveolens — stinkwort

- 1899 — considered useful sheep fodder at Redhill. J. Agric., 2: 1015.

Helianthus annuus — sunflower

- 1946 — still being sown as a fodder crop J. Agric., 49: 449.

Lactuca saligna — wild lettuce

- 1890 — valuable fodder at Melrose. J. Agric., 2: 88.
 1900 — useful fodder (at Pt Elliot). J. Agric., 3: 1015.

Pentzia virgata — sheep bush

- 1897 — growing at Lyrup. J. Agric., 1: 296.
 1900 — growing at Pt Lincoln. J. Agric., 3: 778.

Taraxacum officinale — dandelion

- 1923 — recommended for fodder in combination with sub. clover at Lake Wangary. J. Agric., 26: 580.

Tragopogon porrifolius — salsify, oyster plant

- 1894 — reasonable fodder at Naracoorte. J. Bur. Agr., 6: 195.
 1900 — seed earlier introduced from Central Bureau (for fodder). J. Agric., 4: 392.

CRUCIFERAE

Camelina sativa — false flax, gold of pleasure

- 1891 — seed sent as a pasture species by Central Bureau. J. Bur. Agr., 3: 173.

Diplotaxis tenuifolia — Lincoln weed

- 1907 — seed obtained from Pt Lincoln to be tested elsewhere. J. Agric., 5: 687.
 1918 — introduced to Yunta area as a fodder (Black, 1918).

Sinapis alba — white mustard

- 1923 — fodder at Yallunda Flat. J. Agric., 27: 302.

Sisymbrium orientale — wild mustard

- 1901 — being deliberately sown for fodder at Craddock. J. Agric., 5: 480.

LEGUMINOSAE

Cytisus proliferus — tree lucerne

- 1897 — recommended fodder — J. Agric., 1: 106, 509.
 1899 — Plants distributed at Angaston. J. Agric., 2: 1027.

Lotus tetragonolobus — squarepod trefoil

- 1894 — seed presented by Mueller for distribution to Ag. Bureau Branches. J. Bur. Agr., 7: 125.

Medicago lupulina — black medic

- 1893 — seed distributed by Central Bureau to all branches. J. Bur. Agr., 6: 47.
 1912 — seed for sale. Hackett (1912).

Medicago polymorpha — burr medic

- 1909 — generally common in pastures. J. Agric., 11: 375.
 1912 — seed for sale. Hackett (1912).
 1916 — in plots at Naracoorte. J. Agric., 20: 521.

Medicago rugosa — gama medic

- 1956 — tested at Roseworthy. J. Agric., 60: 268.

Medicago sativa — lucerne

- 1901 — "Hunter River lucerne" sown at Pt Pirie by Mr Mallyon. J. Agric., 5: 185.

Medicago scutellata — snail medic

1955 — recommended for southern Yorke Peninsula. J. Agric., 59: 121.

Medicago truncatula — barrel medic

1938 — shown to be a useful fodder on alkaline soils. Trumble and Donald (1938).

1940 — sown at Gawler. J. Agric., 44: 683.

1946 — recommended for Yorke Peninsula. J. Agric. 49: 492.

Melilotus alba — Bokhara clover

1896 — well established at Millicent as a pasture. J. Bur. Agr., 9: 59.

1914 — *inter alia*, sown at Geranium. J. Agric., 17: 1219.

Melilotus indica — melilot

1906 — fodder plant at Naracoorte. J. Agric., 10: 243.

1908 — sown at Corny Point as, erroneously, "Bokhara clover". J. Agric., 11: 526.

1946 — recommended for fodder on Yorke Peninsula. J. Agric., 49: 492.

Trifolium alexandrinum — berseem clover

1911 — doing well at Roseworthy College. J. Agric., 15: 54.

1912 — being grown at Lyndoch. J. Agric., 16: 88.

Trifolium angustifolium — narrow-leaf clover

1925 — in pasture plots at Kybybolite. J. Agric., 29: 95.

Trifolium arvense — haresfoot clover

1925 — in pasture plots at Kybybolite. J. Agric., 29: 95.

Trifolium campestre — hop clover

1925 — in pasture plots at Kybybolite. J. Agric., 29: 95.

Trifolium clusii — annual strawberry clover

1899 — seed available for sowing from Millicent grower. J. Agric., 2: 938

1944 — valuable at Comaum. J. Agric., 48: 257.

Trifolium dubium — suckling clover

1925 — in pasture plots at Kybybolite. J. Agric., 29: 95.

Trifolium fragiferum — strawberry clover

1894 — valuable fodder at Millicent. J. Bur. Agr., 7: 57.

1904 — doing well at Millicent. J. Agric., 8: 57.

1906 — useful clover spreading in (Adelaide) Hills. J. Agric., 10: 339.

Trifolium glomeratum — cluster clover

1925 — in pasture plots at Kybybolite. J. Agric., 29: 95.

1927 — *inter alia*, tried for pasture at Jamestown. J. Agric., 30: 997.

1932 — *inter alia*, tried for pasture at Copeville. J. Agric., 36: 293.

Trifolium incarnatum — crimson clover

1895 — plants grown from seeds introduced by Agric. Bureau to Millicent doing well. J. Agric., 7: 282.

1899 — spreading at Mt. Gambier. J. Agric., 2: 945.

1925 — in pasture plots at Kybybolite. J. Agric., 29: 95.

Trifolium micranthum — slender suckling clover

1912 — seed for sale. Hackett (1912).

1925 — in pasture plots at Kybybolite. J. Agric., 29: 95.

Trifolium pratense — red clover, cowgrass

1909 — had grown luxuriantly around Mt Gambier and Penola in past but now dying out. J. Agric., 12: 1062, 1064.

1916 — in plots at Naracoorte. J. Agric., 20: 521.

Trifolium repens — white clover

1837 — patches at Glenelg sown by earliest settlers. Farm & Garden, 1: 207.

1909 — had grown luxuriantly around Mt Gambier and Penola in past but now dying out. J. Agric., 12: 1062, 1064.

Trifolium striatum — knotted clover

1925 — in pasture plots at Kybybolite. J. Agric., 29: 25.

Trifolium subterraneum — subterranean clover

1906 — spreading over (Adelaide) hills, good for early feed. J. Agric., 10: 339.

1907 — seed for sale (Hackett, 1907).

1908 — probably the most valuable of our naturalised fodders. J. Agric., 11: 577.

Trifolium tomentosum — woolly clover

1925 — in pasture plots at Kybybolite. J. Agric., 29: 95.

Ulex europaeus — furze

1858 — recommended as a fodder plant. Farm & Garden, 1: 85.

1897 — encouraged as drought fodder. J. Agric., 1: 106.

1900 — recommended as fodder. J. Agric., 3: 651.

Vicia atropurpurea — purple vetch

1950 — being sown on Coonalpyn Downs Development. J. Agric., 54: 140.

Vicia sativa — tares, vetch

1858 — recommended as valuable fodder. Farm & Garden, 1: 10.

1898 — recommended as source of nitrogen for soils. J. Agric., 1: 789.

1950 — being sown on Coonalpyn Downs development. J. Agric., 54: 140.

ONAGRACEAE

Oenothera stricta — evening primrose

1889 — sown successfully in Mannum area. J. Bur. Agric., 2: 89.

1897 — noted as valuable fodder on sandy soils. J. Agric., 1: 43.

1913 — recommended for pasture on sandy country at Monteith. J. Agric., 16: 1193.

OXALIDACEAE

Oxalis pes-caprae — soursob

1914 — regarded by some as good feed at Stockport. J. Agric., 18: 83.

PLANTAGINACEAE

Plantago lanceolata — ribgrass

1837 — planted by the earliest settlers. Capper (1838).

1900 — extensively sown at Auburn. J. Agric., 4: 49.

1931 — still being sown as fodder at Longwood. J. Agric., 34: 986.

Plantago major — greater plantain

1873 — recommended for fodder. (Schomburgk, 1874).

POLYGONACEAE

Polygonum aviculare — wireweed

1859 — valuable summer fodder. Farm & Garden, 1: 153.

1934 — useful for fattening sheep in early summer. J. Agric., 38: 597.

ROSACEAE

Sanguisorba minor — sheep's burnet

1873 — recommended for fodder. Schomburgk (1874).

1907 — growing at Millicent. J. Agric., 10: 912.

1925 — *inter alia*, good pasture at Melrose. J. Agric., 29: 560.

SALICACEAE

Salix spp. — willows

1941 — recommended as being highly nutritious for stock. J. Agric., 44: 635.

Appendix 2

List of alien species with selected references documenting their use for erosion control and other purposes in South Australia.

GRAMINEAE

Ammophila arenaria — marram grass

1893 — successfully established for sandbinding at Corny Pt. J. Bur. Agric., 6: 1.

— one ton to be obtained for coastal plantings at various places. J. Bur. Agric., 6: 60.

Arundo donax — giant reed

1897 — suitable for windbreak. J. Agric., 1: 472.

Ehrharta calycina — perennial veldt grass

1936 — recommended for planting on sane dunes. J. Agric., 40: 32.

1940 — sown at Bute for erosion control. J. Agric., 44: 354.

Paspalum distichum — water couch

1901 — to be introduced as a sandbinder. J. Agric., 4: 632.

Pennisetum clandestinum — Kikuyu grass

1936 — recommended for planting on sane dunes. J. Agric., 40: 32.

Pennisetum villosum — long-styled feather grass

1940 — sown at Bute for erosion control. J. Agric., 44: 354.

Piptatherum miliaceum — rice millet

1940 — sown at Bute for erosion control. J. Agric., 44: 354.

Secale cereale — rye

1936 — recommended for sowing on sand dunes. J. Agric., 40: 32.

Stenotaphrum secundatum — buffalo grass

1936 — recommended for sowing on sane dunes. J. Agric., 40: 32.

EUPHORBIACEAE

Ricinus communis — castor oil plant

1844 — leaves recommended to be placed around grape vines to keep insects away. "S.A. Register", 11.xii.1844.

LABIATAE

Lavandula stoechas — topped lavender

1893 — seed sent to Corny Pt for sand binding. J. Bur. Agr., 5: 279.

— potential perfume plant. J. Bur. Agri., 5: 189.

LEGUMINOSAE

Lupinus cosentinii — blue lupin

1936 — recommended for sowing on sand dunes. J. Agric., 40: 32.

ONAGRACEAE

Oenothera stricta — evening primrose

1936 — recommended for sowing on sand dunes. J. Agric., 40: 32.

RANUNCULACEAE

Consolida ajacis — larkspur

1882 — "for keeping locusts away". Heyne (1882).