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THE NATURALISED FLORA OF SOUTH AUSTRALIA
1. THE DOCUMENTATION OF ITS DEVELOPMENT

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Abstract

Intensive library and archival searches yielded considerably more sources of information concerning the naturalisation of alien plants in South Australia than had been documented hitherto. The material is reviewed chronologically, and its value and the difficulties of its interpretation are discussed. The sources include herbarium specimens, botanical, agricultural and other literature, and records of Parliament and its Select Committees associated with the consideration of noxious weeds legislation.

Introduction

The naturalisation of alien plants started with the advent of Europeans to South Australia and has continued to the present. However there appears to be little documentation of the process, particularly in earlier years. Three studies of the naturalised flora of South Australia were known from last century (Michael, 1972), apart from material scattered throughout the "Flora Australiensis" (Bentham, 1863-1878).

The first was a pamphlet by Schomburgk (1879) which was revised and expanded a decade later (Schomburgk, 1889). This has been reprinted, annotated and discussed by this writer (Kloot, 1980). The second publication was a list of introduced plants collected by Tepper in the vicinity of Ardrossan, Yorke Peninsula during 1878 and 1879 (Tepper, 1880). The third was Tate's (1883a) paper on the natural history of Kangaroo Island in which he included a section on alien plants.

An intensive search for further materials revealed considerably more than those noted by Michael. The additional sources are reviewed and assessed here. Subsequently, the information obtained from them was analysed (Kloot, 1985a, 1987a, b) as part of an intensive study of the development of the South Australian naturalised flora.

At this point, some key words are defined as used in these papers. The definitions are in terms of the South Australian flora and where the terms are applied to that of other regions they are used analogously. Where the words are cited from other writers their meanings may be different.

Acquired species — species originating in other regions of the world, whose presence in South Australia, or southern Australia generally seem to be independent of Man and his activities and preceded European contact (Kloot, 1984), although the process undoubtedly is still proceeding.

Adventive — A plant that is persisting without, or in spite of, human intervention at one or few separate locations, generally for less then 25 years. Generally reproducing only sparingly.

Alien Plant — A species that has reached South Australia in active or passive association with Man, usually in historical times. This means that it arrived after European penetration, which is taken to be 1802.

Casual — A plant that does not persist for more than, say two years, without constant fresh introductions (cf. Tutin *et al.*, 1964-80).

Established — The final stage of naturalisation (q.v.) where an alien plant is widespread over large parts of the State or locally abundant in one or more regions, and generally reproducing freely. Where the distribution is very restricted, the plant should have persisted for at least 25 years (cf. Tutin *et al.*, 1964-80). Mueller's (1853) definition of such a species as one that has spread "beyond the possibility of extirpation" is still a useful perspective. Many authors use the word "naturalised" synonymously with "established" as defined here.

Extinct — No definite records are available of the plant's presence in South Australia since 1950.

Naturalisation — The process by which alien plants are assimilated into the local flora. Three successive stages which merge into each other are recognized, viz. casual (q.v.), adventive (q.v.) and established (q.v.). Hence a **naturalised** species is one that is growing spontaneously, i.e. without, or in spite of, human intervention.

A successfully established plant would have passed from being a "casual", to being an "adventive" and then to being "established". The time scale would depend upon the individual species. A given species may be established in part of the State but merely casual in another area to which it is less adapted.

Volunteer — A species, particularly in an agricultural context, that grows without being deliberately sown by the land manager, in contrast to intentionally *planted* or *sown* species.

Weed — A perjorative, non-biological term expressing the user's perception that the plant concerned has no good properties or possesses deleterious properties. **Weediness** refers to a variable range of characteristics that ensure the persistence of unwanted plants (cf. Baker, 1974). The same characteristics are generally regarded favourably if they are found in desirable plants and are responsible for their persistence.

Sources

In documenting the alien flora, it is necessary to use every reference that can be located. The assessment of the reliability of such material and its interpretation depends heavily on the observer's "taxonomic nous" (Michael, 1972). The records and references may be graded according to reliability, as follows:

1. Herbarium specimens.

2. Records and observations of competent botanists, agriculturalists, and horticulturalists.

3. Detailed observations and comments about specific situations in non-technical literature, e.g. evidence of Select Committees and the survey of *Oxalis pes-caprae* undertaken in 1899-1900 by the Central Agricultural Bureau.

4. Passing references by various observers incidental to the intent of the writing.

Some difficulties encountered in assessing this material include:

1. Ambiguous, illegible or incomplete vouchers on herbarium specimens, particularly early collections.

2. The recognised authorities at different times identified material, usually consistently, but incorrectly according to later determinations. A common mistake was to identify plants as a northern European species rather than as one from the Mediterranean, e.g. *Adonis annua* in error for *A. microcarpus* (Kloot, 1976), *Hordeum murinum* for *H. leporinum* (Cocks *et al.*, 1976). Also, there was much variation between the botanical nomenclature used in the past, and that used currently. These uncertainties were largely overcome by an intensive study of all names used for alien plants by earlier workers and relating them to current nomenclature.

3. Weeds were known by many common names, particularly in the past. Some were extremely localised in their use. The author has personal knowledge of at least six local names for *Pentzia suffruticosa* that were in use in the Mallala area as late as the mid-1970s. One or two names were restricted to about a dozen properties each. Unravelling this uncertainty was greatly aided by publications of Department of Agriculture Officers who added botanical names to the common names recognized by farmers.

An intensive search was made of herbarium, literary and archival material to find further evidence of the time and circumstances surrounding the naturalisation of the species of the South Australian naturalised alien flora. The results of these investigations will be published separately.

Herbarium Specimens

There are about 200 herbarium specimens of alien plants collected in South Australia from the period prior to 1879, almost all of which are lodged at MEL. They were collected mostly by Behr, Blandowski and Mueller, and have been listed and discussed previously (Kloot, 1983). In the majority of cases the material is sufficient for confident determination and it is reassuring to discover that names were applied consistently and largely correctly. The correctness of the names applied to these specimens increases one's confidence in the names used in the literature of that time. Errors seem to be those that were commonly made e.g. *Arenaria serpyllifolia* in error for *A. leptoclados*, *Malva verticillata* in error for *M. parviflora*.

Up to the end of 1878, 97 species of the present naturalised flora had been collected in South Australia for the first time (Kloot, 1987a). However, only six, *Solanum nigrum* — 1869, *Echium plantagineum* — 1870, *E. italicum* and *Dittrichia graveolens* — 1876, *Trifolium tomentosum* — 1877 and *Veronica arvensis* — 1878, are from the period between the departure of Mueller and his colleagues and the advent of Tate and Tepper, which demonstrates the dearth of botanical activity in South Australia at that time (Kloot, 1980, 1983).

After 1879 R. Tate, Professor of Natural History in the University of Adelaide and J.G.O. Tepper (Kraehenbuehl, 1969) began extensive collections and descriptions of the South Australian flora including the introduced species. Tate's botanical specimens were the foundation of the Tate Herbarium that was built up in the University of Adelaide. Tate collected many specimens of naturalised plants including a number of first records. He made a number of specific collecting trips such as his survey of Kangaroo Island (Tate, 1883a), his travels to Eyre (Tate,1888) and Yorke Peninsulas (Tate, 1890b), and to the South-east (Tate, 1883b).

Tepper made extensive collections from various parts of the State (Kraehenbuehl, 1969). Much of his material is found in Melbourne for he sent specimens to Mueller for confirmation. Some specimens were incorporated in the Tate Herbarium but much of his collection was passed through private hands, the Field Naturalists' Society of South Australia and the South Australian Museum. It is now housed in the State Herbarium, Adelaide (Kraehenbuehl, 1969). A lot of this material has been poorly curated and has either deteriorated completely or is in a poor state.

Tepper made particularly comprehensive collections from Ardrossan (Tepper, 1880) and Clarendon where he was stationed at different times as a school teacher. He seemed to collect naturalised plants routinely and is associated with a number of first records for the State.

Although R. Schomburgk, the Director of the Adelaide Botanic Gardens wrote about introduced plants (Kloot, 1980) there appears to be no extant specimens of aliens collected by him.

In the 1870s and 1880s, Mrs Wehl, Mueller's sister, collected widely and included naturalised plants in her collection. In the mid-1890s Miss J.L. Hussey (Kraehenbuehl, 1981)

collected intensively in the Port Elliot area and added many records of naturalised plants. Because they sent their collections to Mueller both of these ladies' collections are at MEL!, although odd specimens have appeared elsewhere.

From 1902, J.M. Black amassed collections particularly from Adelaide and the Mt Lofty Ranges. He adopted a characteristic technique of mounting all his specimens of one species in a single folder to which he attached his drawings and notes about that species. He only started a second folder when he could not fit any more in the first. In later years, he seemed to modify his approach, at least on occasions, and only included one specimen per folder. The diagrams were usually the basis of those used in his books and papers. His annotations provide a rich source of details about the local names, introduction, distribution, economic effects and farmer attitudes towards naturalised plants. He received many specimens from relatives, friends and members of the general public and these are all available at AD where they have been remounted, individually where possible, but still preserving Black's notes and drawings. In some cases he sent specimens of naturalised plants to Kew, Paris or Washington for confirmation of identity. Black's efforts markedly lifted the number of known alien plants and culminated in his handbook of naturalised alien plants (Black, 1909).

From 1909 to his death in 1951 Black dominated South Australian taxonomic botany. He continued to build his collection but from the early 1920s he relied increasingly on others, his own collections being confined to the immediate vicinity of his home. J.B. Cleland collected very widely throughout the State but particularly from the Victor Harbor-Encounter Bay area where he regularly holidayed.

About 1930 the herbarium at the Waite Institute (ADW) was established. It was well-endowed with naturalised species and had a disproportionate share of the first collections for the State. It contained many specimens of plants introduced by the Waite Institute as potential crop and fodder plants and these specimens antedate the first records of the plants as established species. In 1985 this collection was placed on permanent loan in the State Herbarium (AD).

The Tate Herbarium was enriched by T.G.B. Osborne and other staff of the Botany Department at the University of Adelaide, but as far as introduced species are concerned, it became unimportant after the establishment of the Waite Herbarium and a shift in emphasis within the Botany Department to intensive studies of the ecology of native communities by J.G. Wood and others. After the re-establishment of the State Herbarium the Tate Herbarium was lodged there on permanent loan and incorporated into the main collection. Generally, the material has been well-curated and is in good condition.

In 1955 the State Herbarium (AD) was re-established and since then has absorbed many collections by its own staff and others, which have included introduced plants as a matter of course.

Literature records

Early literature

This study has revealed that there is far more early material available than previously suggested (Michael, 1972). The following source material was located by this writer:

a. Behr (1847, 1851, 1891) — covering the period 1844 — 1849.

b. McEwin (1847) — contemporaneous.

d. Mueller (1850, 1853, 1858-82) — covering the period 1847 — 1852.

d. Francis (1855) — contemporaneous.

e. "Flora Australiensis" (Bentham, 1863-78) — with regard to the naturalised flora of South Australia, the records are largely those of Mueller and others up to 1853 with scattered later records particularly in the last volume.

These sources have been discussed in detail already (Kloot, 1983), apart from McEwin's article from which a number of species were mentioned in passing. The different treatment accorded McEwin's article, in spite of his training as a landscape gardener and his considerable ability as a botanist (Pascoe, 1901), was justified because his comments were general and not supported by any collections that could be considered as voucher specimens for his paper. Apart from "want of leisure", he was also lacking a "good work on the Flora of Britain", which handicapped his investigations in these matters (McEwin, 1847). Further species noted in his article will be mentioned below.

The general press, reflecting the interests of a largely agricultural society, made passing references to the occurrence of weeds and the problems they caused. Later came the establishment of more specialised publications catering for the agricultural and horticultural community. Prior to 1880 these were the short-lived "South Australian Horticulturalist" (1856), "Farm and Garden" (1858-1863) and "Garden and Field"(1875-1940). Albert Molineux (1832-1909) was an astute and reliable observer whose local experience reached back to 1839. He was a key figure in the agricultural press, being the first editor of "Garden and Field". He also made substantial contributions to later publications. His articles and notes on weeds bear a ring of authority and in all cases where cross-checking is possible, his comments are vindicated.

The earliest definite record in the literature of an alien plant other than as a crop is that of *Verbena officinalis* growing on the banks of the Torrens River in 1837 (Kloot, 1985b). *Datura stramonium* and *Silene gallica* are reputed to have been introduced by 1839 and 1840 respectively, and *Avena fatua* is claimed to have been introduced in the first cereal seed imported (Kloot, 1985b). In the Gardener and Farmer's Calendar for 1839 (Stevenson, 1838), the notes for August include "check the growth of weeds". For December the advice is, *inter alia,* "Free the garden from weeds before they drop their seed". Such comments are frustrating because they give no idea as to what the species were, but I suggest that they would have been the same species introduced in other places by Europeans (Kloot, 1985b). These weeds would have arrived in contaminated seed, contaminated soil around potted plants, or from propagules attached to implements.

Arctotheca calendula and *Cirsium vulgare* were both recorded as established in 1841, *Onopordum acaulon* had escaped by 1845 and *Ricinus communis* was growing on a rubbish heap by the mid-1840s (Kloot, 1983). *Oxalis pes-caprae* appears to have been troublesome by 1855 (Kloot 1983). *Trifolium repens* was noted as naturalised in gullies of the Adelaide Hills in 1859 (Farm & Garden *1*: 207). *Marrubium vulgare* was observed to be growing densely near Bullaparinga (near Second Valley) in 1850 (Yelland, 1970).

McEwin's (1847) article is only of limited value for the reasons mentioned earlier. Apart from the species that were noted by Kloot (1983), he also recorded, *inter alia*, the following species: *Rumex crispa* (i.e. *R. crispus*), *Areneria rubra* (i.e. *Spergularia rubra*), *Stellaria graminea* (prob. *S. palustris*) and *Erodium* (*E. cicutarium* and *E. moschatum*). As all these species were collected by Mueller (Kloot, 1983), McEwin's implication that they were successfully established seems well-founded. Other references are too vague, e.g. "*Senecio* — very similar to *S. vulgaris*", or involve confusion between native and introduced taxa, e.g. *Oxalis, Geranium.*

In his lecture on "Pasture Grasses", Francis (1859) mentioned that brome grasses (*Bromus* spp.) and barley grass (*Hordeum glaucum*) were troublesome to stock, which implies that already they were well-established by that time. Mueller had noted weedy *Bromus* spp. about Adelaide in 1847 and had collected *H. glaucum* in 1848 (Kloot, 1983).

References to *Dittrichia graveolens* as stinkweed or stinkwort are found in the popular press of the period as it spread very quickly throughout the cropping areas. The most complete account of its introduction, establishment and initial spread in the 1860s was written some time later by Grassby. This account was preserved by Maiden (1920). Considering Grassby's fairly

definite dating of this plant's establishment near Balhannah to be within a year or two of 1865, it is startling that the earliest extant herbarium specimen is from 1876, and it indicates the necessity to cross-check data wherever possible.

During the period to 1879, most references to weeds or weed control in the agricultural press were general, without mentioning particular species. However, this changed completely by the 1880s with the rise of the Agricultural Bureaux.

Schomburgk (1870, 1889) contributed a short treatise on the naturalised alien plants of South Australia. This pamphlet is a disappointing source of reliable information about the subject (Kloot, 1980).

Another source of information is the series of annual reports of the Director of the Adelaide Botanic Gardens (Schomburgk, 1867 *et seq.*) in which he wrote of the major weed problems encountered in the Garden or in the adjacent parkland (Botanic Park).

Tepper's (1880) paper on the flora about Ardrossan is of interest because it was a systematic analysis of the flora of one part of the settled areas and because it was the first paper to consider alien plants as a group by itself. Tepper in common with other authors of that period considered a number of species to be native which we now know to be introduced and also used names of aliens erroneously for native species (Kloot, 1980).

Voucher specimens which were identified or confirmed by Mueller, still exist for the paper although many have deteriorated completely. The remaining material is housed at AD! and it is possible to realise Tepper's errors in determining *Nicotiana glauca* as *N. suaveolens*, and in his application of the names *Sagina apetala* and *Spergularia rubra* to native Caryophyllaceae. However it must be stated that most of the remaining material appears to be correctly identified.

His list, which includes 30 alien species, does not actually record any first records for South Australia, although for many species it remains a first record for Yorke Peninsula.

Tate (1883a), in his pioneering study of the Kangaroo Island flora, examined the relationships between the island flora and that of the mainland, other parts of Australia and other parts of the world. He listed the "extra-Australian" species found on the island and these are a mixture of alien, acquired (Kloot, 1984) and mis-identified native species. He also commented on the "alien plants" *per se*.

A total of 51 naturalised alien species can be identified from his paper, but voucher specimens for many of them are missing. Those that are still extant are in good condition and provide a valuable supplement to the remainders of Tepper's collection.

However, there are no first records for South Australia and there is considerable overlap with the species listed by Tepper (1880), which suggests that a number of common weeds were already widespread by this period.

Journals and periodicals

In 1875 the "Garden and Field" was launched edited by Albert Molineaux. This journal provided a forum for the exchange (and permanent record) of much agricultural and botanical information relevant to this study. Many first records were obtained from that publication.

The Royal Society of South Australia was originally formed as the Philosophical Society in 1853. Records of meetings and activities were printed in the daily press until 1877 when the publication of the "Transactions and Proceedings" commenced. Apart from many scientific papers, the minutes of the meetings and records of excursions provided much material for this study. In 1883 the Field Naturalist's Section of the Royal Society was formed and for many years its records were published as a supplement to the Royal Society volume. Eventually its own journal the "South Australian Naturalist" was established in 1919. All these provide further sources for first records.

Under the influence of Albert Molineux the Central Agricultural Bureau was founded in 1888. At the outset its records were published in the "Garden and Field", but later in the same year the "Journal of the Bureau of Agriculture of South Australia" was established as a separate organ. Molineux, beside being General Secretary of the Bureau was the Editor of the Journal. The Journal ceased publication in 1897 when the "Journal of Agriculture" was launched. Details of plant specimens sent for identification and other information contained in these publications are a rich source of information about the introduction and spread of weeds.

Because of the more abundant literature and the availability of herbarium specimens, records may be cross-checked and consequently their reliability is greatly enhanced.

Black's writings

Black (1909) sought to complement Tate's (1890a) handbook of the native flora by producing a work on naturalised aliens. The species were systematically arranged and a description was provided for each species together with distribution and economic notes. The book was well-illustrated with Black's own drawings. The book was a milestone in South Australian botany and indeed Australian botany. It was the first Colonial or State flora that was not based on the "Flora Australiensis" (Bentham, 1863-1878) and the book was the basis of the first two editions of Black's Flora of South Australia (Black 1922-28; Black 1943-52; Robertson, 1957).

Black's Flora included naturalised aliens with the native species. The records are supported by Black's own specimens now at AD! In general, Black's earliest literature reference regarding the later established species is generally to his long-running series of "Additions to the Flora of South Australia" published in the "Proceedings of the Royal Society of South Australia" between 1907 and 1951.

Eichler's supplement (1965) retained the format which was continued into the third edition of the first volume (Jessop, 1978) but it has finally been abandoned.

Department of Agriculture publications

Apart from its journal, various scientific and extension reports, papers, pamphlets and bulletins also provide information on the introduction and establishment of alien plants. Thus the earliest Annual Reports for 1882 and 1883 *inter alia* list many species being tested for fodder at Roseworthy. As some of these species, such as *Ulex europaeus* and *Plantago lanceolatus* are not considered suitable for such purposes nowadays such records provide an insight to their earlier novel uses. Andrew (1916) reports on pasture and crop seed contamination by weeds which have been continued by subsequent reports of the Seed Testing Laboratory. There has been a steady production of literature on weeds and their management and also on plant introduction e.g. pasture species for alkaline (French and Young, 1962) and saline areas (Matheson, 1968; MacPhie, 1973).

Much Departmental work, particularly up to the 1950s, was done by or in collaboration with the Waite Agricultural Research Institute. Indeed much of the early work of that Institute was published in Departmental media.

There also exists further records contained in Departmental files and dockets. As an example, a study of the relevant dockets by this writer revealed the history of the introduction of *Spartina* x *townsendii* which was passed on to K.G. Boston and included in his comprehensive treatment of that plant in Australia (Boston, 1981).

Noxious weeds legislation

In the twentieth century, by the time that a weed had spread so extensively that proclamation was being considered, records and herbarium specimens were available which diminished the importance of evidence to Parliamentary Committees or the records of

Table 1 — *South Australian Noxious Weeds Legislation*

Short Title	Purpose	Associated papers
Thistle Act, 1851	An Act for preventing further spread of the Scotch thistle	S.A. Parl. Paper No. 19/1851
Thistle and Burr Act, 1862	An Act for preventing the further spread of Scotch thistle, variegated thistle and Bathurst bur.	S.A. Parl. Paper No. 205/1862
Thistle and Burr Act, 1887	An Act for amending No. 26 of 1862 and for preventing the further spread of star thistle.	S.A. Parl. Paper No. 102/1887

The following Acts dealt with administrative matters but do not provide information relevant to this study not available from other sources.

Noxious Weeds Destruction Act, 1891

Destruction of African Boxthorn Act, 1925

Noxious Weeds Act, 1931-1939

Local Government Act, 1934-1976

Noxious Weeds Act, 1956

Pest Plants Act, 1975

Parliamentary Debates as bases for historical investigation of weeds. For last century however, such documents are very useful sources (Table 1). Much of the information is anecdotal but the 1862 Report is especially valuable because of G.W. Francis' evidence and his drawings of the various species that were under consideration.

The Thistle Act, 1851, was the first noxious weeds legislation to be enacted in Australia. From the Parliamentary debate, the report of the Select Committee and the wording of the Act itself, it is possible to determine which species were included in the legislation. In the Act the expression "plants commonly known in this Province as the Scotch Thistle", or some variation, keeps recurring. The last clause, which is purely interpretative, states" . . . 'Plants commonly known in this Province as the Scotch Thistle', shall be held to mean and include (in addition to all other plants so commonly known), the variegated thistle, and the plants commonly known by the botanical names of 'Carduus Marianus', and of 'Carduus benedictus' . . .".

It must be stated quite firmly that the real Scotch thistle (*Onopordum acanthium*) is not the weed being considered. This species has always been uncommon in South Australia. Spear thistle (*Cirsium vulgare*) was very widespread in the settled areas of South Australia having been introduced in 1841 (Kloot, 1983) and this weed was generally known as "Scotch thistle". However, the clause . . . "all other plants so commonly known" . . . potentially includes many more species for almost all of the purple-flowered thistles are called, at times, "Scotch thistle". This was particularly common last century. The specific inclusion of variegated thistle (*Silybum marianum*, syn. *Carduus marianus* and in error, *C. benedictus*) which is readily distinguished from other thistles by its characteristic leaf marking, effectively extends the scope of the Act to cover all purple-flowered thistles present at that time (Kloot, 1983).

The enactment of the 1851 Thistle Act is proof that both *Cirsium vulgare* and *Silybum marianum* were well-established, aggressive weeds by that time, for the preamble to that Act states clearly: "Whereas great injury and loss have been and are occasioned to the cultivated and waste lands of this Province, by the spread of the plants known as the Scotch Thistle . . .".

In the 1862 Act, the only addition was Bathurst burr (*Xanthium spinosum*). According to evidence presented to the Select Committee investigating the matter, this pest had only been

observed for the first time about 1850, so at the time of the earlier Act, *X. spinosum* would only have been a minor weed. Apparently it was confined to roadsides and stock reserves within the agricultural area but when it reached the interior, it spread with alarming rapidity. Whilst the thistles were agricultural weeds, Bathurst burr was held to be "as dangerous a weed as the sheep farmers have to contend with".

No further legislative action was taken until 1887. From the Evidence to the Select Committee enquiring into the Bill and other records it is quite clear that the "star thistle" of this Act was the plant now called saffron thistle (*Carthamus lanatus*). This weed was spreading throughout the northern cereal areas and causing havoc in crops, particularly at harvesting.

It is also clear from references to a purple flowered star thistle in the south-east and the yellow flowered "star thistle" in the north, that witnesses before the Select Committee from each of these areas were referring to *Centaurea calcitrapa* and *Carthamus lanatus* respectively.

The later legislation only dealt with administrative changes but did not provide any information relevant to this study not available from other sources.

Conclusion

The material reviewed here yielded considerable information about the development of the naturalised flora of South Australia. Earlier writers underestimated the amount of material available and it is likely that further investigations may reveal more details. Diaries and letters of early settlers are likely to be rewarding. At present there are still many frustrating gaps in our knowledge, particularly concerning the unintentionally-introduced species.

A number of likely horticultural introductions are obscured by nomenclatural confusion, and the locating of old catalogues and plant lists may assist in clarifying such cases.

From the records mentioned here a checklist of the naturalised alien flora of South Australia was compiled (Kloot, 1986).

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