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THE NATIVE AND NATURALISED *CYPERUS* SPECIES IN SOUTH AUSTRALIA

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Abstract

The 25 species of *Cyperus* recorded in South Australia are considered in terms of their distribution ranges. It is concluded that *C. bulbosus, C. difformis, C. exaltatus, C. iria, C. pygmaeus, C. rotundus* ssp. *retzii* and *C. squarrosus* range through the tropics, extending southwards to the eremaean zone of South Australia; and *C. clarus, C. cunninghamii, C. dactylotes, C. gilesii, C. gunnii, C. gymnocaulos, C. rigidellus, C. rutilans, C. vaginatus* and *C. victoriensis* are endemic to Australia. Of the remainder, *C. arenarius, C. congestus, C. eragrostis, C. flabelliformis, C. laevigatus* and *C. tenellus* are considered to be introduced to Australia, whereas *C. brevifolius, C. rotundus* and *C. sanguinolentus* are probably native to eastern Australia but introduced to South Australia.

It is suggested that there are no natural disjunctions of species between temperate Australia and other temperate areas. Those that have been recorded are due to misidentification or other errors.

Introduction

A significant piece of information found in each entry in most floras is the plant's status as an exotic or native. A standardised notation has been developed where the presence of an asterisk preceding the botanical name indicates an exotic species. Perhaps the physical insignificance of this symbol has led to a general underestimation of the importance of the information that it is meant to convey.

Yet the question of whether a given species is native or introduced is of great significance. Evolutionary theorists, plant geographers and taxonomists use this information to arrive at some of their major decisions. In contrast to the other species' data found in floras which is generally a distillation of various measurements and observations, the plant's status is an opinion. In the early days, misidentifications, incomplete knowledge of patterns of European settlement and related plant introduction, uncertain localities of early records and underestimations of how far and how fast plants may spread, led to errors in assessing the status of Australian plants.

With the benefit of hindsight and a better knowledge and understanding of the facts enumerated above, a number of corrections can be made to early publications. For example, Bentham (1863-78) included 145 species which are now known to be alien to South Australia. However, of these he recorded that 91 were native to Australia (Kloot, unpublished data). In later years the more obvious mistakes were rectified, yet the weight of tradition is not easily dislodged and some of Bentham's errors still persist. For example, *Alyssum linifolium* Steph. ex Willd., considered to be native to Australia by Bentham (1863), was still recorded as such by Black (1948) and Willis (1972) although the error has since been appreciated and will be amended in a future publication (H.J. Hewson; *in litt.). Emex australis* Steinh. was recorded as native by Bentham (1870) and is still recorded as an Australian native by Airy Shaw (1973) and Good (1974). Both these latter works are considered authoritative in their fields and this error (among others) will continue to be disseminated.

In this paper, the status of the South Australian species of the genus *Cyperus* have been examined but it is believed that the approach may be more widely applicable. This is not a taxonomic revision and the nomenclature used is that of Jessop (1978). It is hoped that the findings presented here will harmonize with such a revision presently being prepared by Mrs Karen Wilson (NSW).

Procedure

The locality records of herbarium specimens and distribution data provided in the published floras of South Australia, Australia generally and other countries were examined. The nature of the habitats where the respective species were found was also considered. Herbarium specimens were examined to ensure that names were used consistently (although whether they were used correctly must wait for Mrs Wilson's taxonomic revision).

Attention is also paid to the date of first records and their respective locations in the light of European exploration and settlement in that area at that time. No assumptions were made beyond those made in flora writing, i.e. that data derived from collections provide a factual basis for assessing distribution, and that later revisions and distribution data therein are more accurate than conclusions reached last century in the early days of general exploration and botanical investigation in the Australasian region. In the interpretation of such data and in forming conclusions, assumptions about plant distribution must be made which will be discussed further on.

Discussion

The genus *Cyperus* is pantropical extending into warm temperate regions (Airy Shaw, 1973). In South Australia, 25 species are recorded of which four are considered introduced (Jessop, 1978). If all of the species are grouped according to their ranges within South Australia, and according to their contiguity with other populations in Australia and beyond, five types of distribution are immediately apparent.

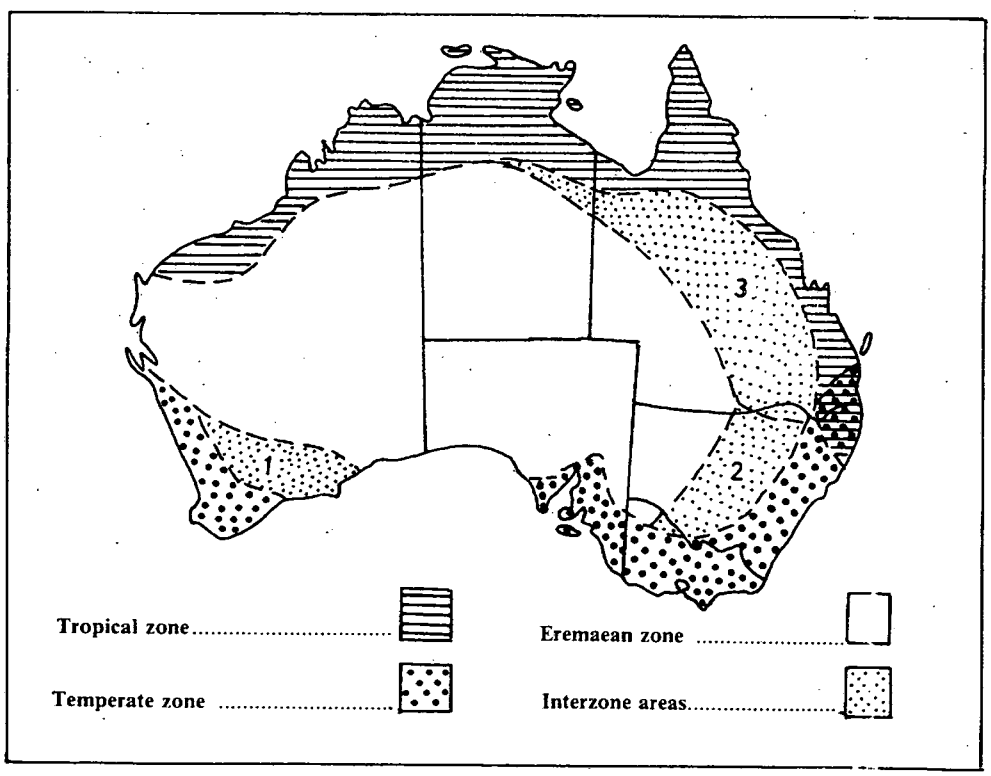

Fig. 1. The principal floristic zones of Australia (after Burbidge, 1960).

1. Tropical, extending to South Australia

Within Australia, these species occupy Burbidge's (1960) tropical and eremaean zones and her interzones 2 and 3 (Fig. 1). The South Australian populations are on the southern edge of their range. In all cases the local populations are continuous with those in adjoining States and in adjoining countries from where they are also recorded as native e.g. Java (Backer and Bakhuizen van den Brink, 1968) and Malesia (Kern, 1974).

Within South Australia these species are found in the north of the State, not occurring farther south than the Flinders Ranges and Eastern (occasionally Murray) regions delineated by Jessop (1978). These species are:-

C. bulbosus Vahl
C. difformis L.
C. exaltatus Retz.
C. iria L.
C. pygmaeus Rottb.
C. rotundus L. ssp. retzii Kuek.*
C. squarrosus L.

2. Endemic to Central and Northern Australia

This group has the same distribution within South Australia and occupies the same botanical zones (Burbidge, 1960) in Australia as the previous one. However these species are not found beyond Australia. In some cases, the ranges are quite small but these are within the general area as defined.

The species are:-

C. clarus S.T. Blake
C. cunninghamii (C.B. Clarke) C.A. Gardner
C. dactylotes Benth.
C. gilesii Benth.
C. rigidellus (Benth.) J.M. Black
C. victoriensis C.B. Clarke

3. Endemic to Southern Australia

Within Australia, the species of this group are found in the temperate and eremaean zones and interzone 2 (Fig. 1). The South Australian records of this group occur throughout the State. Local populations are continuous with populations in adjoining States.

The species are:-

C. gunnii Hook. f.
C. gymnocaulos Steud.
C. rutilans (C.B. Clarke) Maiden & Betche
C. vaginatus R.Br.

4. Disjunct Australian populations

In this group, the range of each species within South Australia and Australia generally is restricted. Separated populations or stands in different localities are common. But the major distinguishing factor of this group is that the Australian populations are disjunct with populations outside the continent. This is to be contrasted with the first group which is continuous through the islands to the north and north-west of Australia to Asia and beyond.

The species, their origins and status according to Jessop (1978) are as follows:-

* Nomenclature after Jessop (1978). This is considered to be a distinct species, *C. bifax* C.B. Clarke (cf. Blake, 1942).

Species	Origin	Status according to Jessop (1978)
C. arenarius Retz.	Asia	Introduced
C. congestus Vahl	South Africa	Introduced
C. eragrostis Lam.	South America	Introduced
C. flabelliformis Rottb.*	Africa, Arabia	Introduced
C. laevigatus L.	Mediterranean	Native
C. tenellus L.f.	South Africa	Native

5. Disjunct South Australian populations

In this small group, the South Australian populations are disjunct with those found elsewhere in Australia, in particular, those of the north-east coast and adjacent areas, populations which are continuous with those of adjacent countries and almost certainly natural extensions of their tropical range. The South Australian records are restricted almost entirely to the Adelaide area and adjacent southern hills. Jessop (1978) regards them all as natives.

The species are:-

C. brevifolius (Rottb.) Hassk.
C. rotundus L. ssp. *rotundus*
C. sanguinolentus Vahl

The introduced species

In the last two groups the disjunction of the South Australian populations, in particular, is taken to indicate that those species are not native to this State but are introduced to their present locations. To allow further discussion about these cases and the principles that may be drawn from them, each of the species with disjunct South Australian distribution will be discussed.

1. *C. arenarius*

This species has not been recorded anywhere in Australia apart from its single occurrence at Port Augusta where it was first recorded in 1961 (Symon, 1964).

2. *C. congestus*

This is a garden escape first noted as a weed at Burnside in 1940 (Blake, 1943). It is now found in the Adelaide Hills and lower south-east.

3. *C. eragrostis*

Another garden escape that has been collected once in the south-east, which was the first local collection (in 1961), and a few times in the Adelaide area.

4. *C. flabelliformis*

A further garden escape which has become established in a small persistent patch in Waterfall Gully where it was first collected in 1942 (Blake, 1943).

5. *C. laevigatus*

The first collection in South Australia was made by Helms at Nilpena in 1891 (Black, 1919). It was recorded as *C. distachyos* All. from both the Mt Lyndhurst run and from Middleton Creek, near Goolwa in 1898, and a further collection made at Coward Springs, west of Marree in 1919 (Black, 1919). Specimens lodged under that name in AD have been collected widely throughout the State since, particularly from the interior. However upon examination, the southern collections are quite different in appearance to the northern material, upon which the locally published descriptions of the species are based. Blake (1943) compared central Australian material with genuine Mediterranean specimens and found that they were identical. It is suggested that this southern material is another species, which is discussed below as *Cyperus* sp.

* Nomenclature after Jessop (1978). Baijnath (1975) establishes that the correct name is *C. involucratus* Rottb.

Black's (1919) concluding comment of his discussion of the species was that it "is a Mediterranean plant, but it is doubtless native here". However, that a species is widespread in the interior is no proof that a species is native. Similar cases of plants of Mediterranean origin that are widespread in the interior but rarely found in southern areas are *Glaucium corniculatum* (L.) Rudolph and *Schismus arabicus* Nees among others.

It is possible that the introduction of this plant to the interior may have been associated with the introduction of camels and their drivers. This occurred in the case of *Scirpus hamulosus* (M. Bieb.) Steven which occupies similar habitats in the same region (Blake, 1943).

6. *C. tenellus*

Bentham (1878) unequivocally regarded this species as being native to Australia, South Africa and New Zealand. This was despite the fact that at that time it was only recorded from Parramatta in New South Wales and from Western Australia (two collections by Drummond). Mueller (1874), however, in the first record of this species in the Australian literature had clearly stated "in Australiam occidentalem extratropicam migravit". But even the latest Australian floras — Burbidge & Gray (1970); Willis (1970); Beadle *et al.* (1972) and Jessop (1978) follow Bentham. However, Moore and Edgar (1970) state that it is no longer regarded as indigenous to New Zealand.

Within South Australia it was not recorded by Tate (1880) as being present, but was subsequently recorded for this State by Mueller (1882) and Tate (1890) who recorded it as being present in his region "A" i.e. the Adelaide area. These records must have been based on the following early collections: St Vincent's Gulf, Tate, 1882 (MEL!); Square Waterhole, Tate, 7.i.1882 (AD!); Square Waterhole, along banks of drain, *Tepper 1065*, 4.ix.1882 (MEL!); Government farm (i.e. Belair National Park), 24.ix 1883 (AD!); South Para River, Tepper, 21.x. 1888 (MEL!).

Even today it has three disjunct ranges within South Australia, an area within about 35 km radius of Port Lincoln on Eyre Peninsula, the Adelaide Hills from the Barossa Valley to Cape Jervois and extending onto Kangaroo Island, and scattered records from the lower south-east. This latter range appears to be separated from the nearest Victorian population (Willis, 1970) which is in the Grampians.

It is suggested that this is a South African species which was inadvertently transported from the Cape of Good Hope where it is common (Adamson and Salter, 1950).

7. *C. brevifolius*

This species is native to the islands north of Australia (and beyond) and was collected by R. Brown at Port Jackson and other places on the eastern seaboard before 1805 (Brown, 1810) as *K. monocephala* Rottb. Further collections were made quite widely in the same general area in later years and these are recorded by Mueller (1874) and Bentham (1878). A closely related species native to eastern Australia was also listed by Brown (1810) and Bentham (1878) as *K. intermedia* R.Br. and the latter has appeared presumably erroneously, in the local literature.

In South Australia this species was first recorded by Tate (1880) as *K. monocephala* from his region "M" i.e. Murray. Black's (1943) record of *C. brevifolius* from the River Murray is presumably based on Tate's record. A record of *K. intermedia* from the Adelaide area was given by Tate (1890). No specimens could be found upon which these records were based. There are only three other records and they are from Adelaide; in a lawn at the Waite Institute in 1931 (AD 95519093!), from a couchgrass tennis court at Magill in 1961 (ADW 23628!) and from another Adelaide garden in 1964 (ADW 27826!).

In the eastern States and particularly in the metropolitan areas of the major cities, this plant is an important lawn weed. It may be assumed that if this species did occur locally it would also be found in lawns (as the cited specimens show) and would be a source of concern

or at least curiosity. In other words it is most unlikely to be widespread but not recognized. The conclusion is drawn that this species is not native but is a casual introduction probably from eastern Australia.

8. *C. rotundus* ssp. *rotundus*

The early records of this species were quite similar in respect to location and data as *C. brevifolius*. However early records from Victoria and other southern locations were based on misidentifications particularly of *C. victoriensis* C.B. Clarke and *C. bulbosus* Vahl (Blake, 1942).

This sub-species is not native to South Australia. Early records of Tate (1880, 1890) may be ascribed to ssp. *retzii* in the far north and to misidentifications as mentioned.

The first recorded introduction of *C. rotundus* was as a garden plant into the Botanic Garden in 1884 (Annual Report, 1885). This material was of unspecified "Australian" origin. It seems to have been foolhardy to introduce the plant as it was already known to be a major weed problem in the Sydney Botanic Garden as early as 1858 (Michael, 1972). By 1899 it was recorded (Anon. 1899) that "this weed is frequently introduced with dahlia roots and other plants from New South Wales and Queensland and has already gained a hold in several places in South Australia".

However, a more potent method of introduction was that associated with the cultivation of "groundnuts" or "chuffas". These were the tubers of *Cyperus esculentus* L. which were roasted and nibbled as a snack much as we use peanuts or potato chips. Heyne (1871) was already recommending their growth. A further introduction of material of unknown origin to the Botanic Garden took place in 1879 (Annual Report, 1880) and in 1891 the Central Bureau of Agriculture introduced seed which was distributed to Agricultural Bureaux throughout the State (Anon. 1891). Demand was so great that the Bureau was forced to appeal to members to donate bulbs for further distribution (Anon., 1895). This culinary fad had passed by the first years of the century and plantings were abandoned. It is suggested that due to honest misidentification and a little bit of fraud most of the so-called *"C. esculentus"* that was being circulated was probably *C. rotundus*. This was most likely in the last years of the century when demand was great. The sudden end to the fad could well have been caused by just this substitution of species, for, whereas the roasted tubers of *C. esculentus* are sweet and apparently appetizing, those of *C. rotundus* are bland and starchy. Certainly, regardless of what was being planted as *C. esculentus,* only *C. rotundus* has survived.

The end result was that the abandoned plantings died out where there was no permanent water over summer, but along creek beds and other favoured places, the plant persisted and in places thrived. Half a century later, those same places were turned into loam pits for the Adelaide metropolitan area. This has resulted in the widespread movement of this difficult weed to gardens, particularly newer ones, throughout the Adelaide area. In the older suburbs, populations may be remnants of original plantings.

9. *C. sanguinolentus*

The early records of this species were from the same areas as those of *C. brevifolius* with an anomalous record from South Australia collected by Mueller in 1847 in the "Mt. Lofty Range, near the source of (River) Torrens" (MEL!). It was recorded by Bentham (1878) as *C. eragrostis* Vahl. Mueller (1874) had earlier referred to this species but his synonymy differs from that of Bentham. Apart from taxonomic uncertainty, the habit of the plant is also confused in the literature. Bentham (1878) described it as a perennial and he was followed by Ewart (1930) and Willis (1970). However the South Australian material is recorded as annual (Black, 1943; Jessop, 1978) which is also the finding of Burbidge and Gray (1970). Clarke (1884) in his major study of the genus records it as an annual. The apparent contradiction may be due to flowering in the first year (Bentham, 1878; Beadle *et al.,* 1972).

Black (1922) noted Mueller's record but stated that it did not appear to have been found since in South Australia. Since 1921 it has been collected intermittently from four locations (of which two may be the same place). These are "Encounter Bay" where it was first collected by J.B. Cleland in 1921 (AD 966040854!) and "swamp north of bluff, Encounter Bay" where it was also collected by Cleland in 1933. It was also collected in a swamp in Cleland's Gully, Tooperang, near Mt. Compass in 1926, 1939 and 1942. The identity of the 1939 specimen was determined by S.T. Blake (Black, 1940). More recently, in 1968, a further collection was made in a swamp at Yundi which is also near Mt Compass. All these sites are within 25 kilometres of each other.

It is concluded that this species is not native to South Australia. It has been introduced from the eastern States or from overseas, at different times and seems to persist for only short periods. Its introduction may be associated with the movement of cattle from the eastern States as its stations in this State including Mueller's, are all swampy areas that have been grazed by cattle. The status of this species is difficult to determine and a detailed study would undoubtedly throw more light on the natural range of this difficult species, whose growth habit is not even known with certainty.

10. *Cyperus* sp.

Eight collections of this species in AD, previously determined as *C. laevigatus* have been made from the Picanninie Blue Lake near Mt Gambier, in 1963 (3 specimens), 1972 and 1974, from Salt Creek, on the Coorong in 1974 and from near Encounter Bay in 1926 and 1934. It has some morphological features in common with *C. laevigatus* such as the terete stems and colouring on the glumes. However, whereas *C. laevigatus* only has one or occasionally two spikelets, this species has clusters of up to twelve spikelets. I leave the identification of this species to a specialist in the genus, after which its status may be assessed.

Conclusions

In the preceding discussion, continuity of range has been accorded cardinal importance in assessing each species' status as a native or an exotic. Where the distribution of a species of *Cyperus* in Australia is merely an extension of a general range from the islands to the north of the continent, it is concluded that its occurrence here is not dependent on the activities of man, particularly of Europeans. Such species are tropical species, which in Australia may extend into the eremaean zone including the northern regions of South Australia. A continuous environment permits a continuous range.

However, in contrast to its tropical regions, temperate Australia is completely isolated from other temperate areas — from those in the northern hemisphere by the tropics and sub-tropics and from those in the southern hemisphere by the oceans. This isolation has existed since the early Tertiary, about 40-50m years B.P. (Schuster, 1976; Thorne 1978). So in this case, identical populations occurring disjunctly in Australia and overseas could only have arisen as relics of a former continuous population that existed before isolation or as a result of long-range dispersal.

The possibility that a species already developed before isolation could maintain identical populations in two eventually distant locations which were subject to quite different environmental conditions over a very long period is considered to be negligible. Similarly, the chance that even a common ancestor, since disappeared, could give rise to disjunct populations of identical species in spite of the great differences in environmental conditions over the vast time scale is also concluded to be negligible. Raven (1971) has reached similar conclusions in his discussion on the evolution of the respective floras of the areas of Mediterranean type climate throughout the world.

So by rejecting the possibility of the occurrence of natural disjunctions of species from temperate Australia to other temperate regions, it is possible to reassess the status of the South Australian *Cyperus* species as follows:

Native to South Australia

1. Extra-Australian
   C. bulbosus, C. difformis, C. exaltatus, C. iria, C. pygmaeus, C. rotundus ssp. *retzii* and *C. squarrosus.*
2. Endemic to northern Australia (and adjacent areas)
   C. clarus, C. cunninghamii, C. dactylotes, C. gilesii, C. rigidellus and *C. victoriensis.*
3. Endemic to southern Australia (and adjacent areas).
   C. gunnii, C. gymnocaulis, C. rutilans and *C. vaginatus.*

Introduced to South Australia

1. Native to the tropical eastern Australian coast
   C. brevifolius, C. rotundus ssp. *rotundus* and *C. sanguinolentus*
2. Introduced to Australia
   C. arenarius, C. congestus, C. eragrostis, C. flabelliformis, C. laevigatus and *C. tenellus.*

A similar approach was used in assessing the status of Australian species of the family Brassicaceae (H.J. Hewson, *in litt.)* and it will probably be useful for other species also. It is suggested that where there is an apparent disjunction overseas at the species level, there has either been a misidentification, or the plant is introduced. Many examples of the former situation are available where Australian endemics were originally misidentified, usually as European plants, which gave rise to apparent disjunctions. The correct determinations made in later years disposed of the problem. Some examples are:- *Lepidium ruderale* L. in error for endemic *Lepidium* spp. *Geranium dissectum* L. in error for *G. pilosum* Forst., *Typha angustifolia* L. in error for *T. orientalis* C. Presl. and *T. domingensis* Pers., *Tragus racemosus* (L.). All. in error for *T. australianus* S.T. Blake and *Glyceria fluitans* (L.) R. Br. in error for *G. australis* C.E. Hubbard. The other case, where introduced plants were formerly considered to be native, was briefly discussed earlier.

Where species occur naturally in other parts of Australia, it is more difficult to decide as to their status in disjunct local populations. However, with the *Cyperus* species considered here, it is noticeable that their South Australian distributions and habitats differ from those of their apparently natural range. They may be less common, of known introduction or occupying only one or very few of the range of habitats in which it is found elsewhere. This is in contrast to the relic disjunctions discussed by Crocker and Wood (1947) and more recently by Randall and Symon (1977) where isolated occurrences of a number of species are associated with isolated areas of similar environment. The time spans involved here are only a fraction of those involved in the isolation of the Australian continent. Randall and Symon concluded that the relic populations, now separated by the desert sands of Central Australia were part of a single population only 30 000 years ago. Yet even in that time two populations of *Acacia* have diverged to such an extent that they are regarded as separate species: *Acacia sowdenii* Maiden and A. *loderi* Maiden. This further supports the earlier contention that it would be inconceivable that over the longer period since the separation of Australia from the primordial land mass that any species could develop to become, or remain, identical to another population in another continent.

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