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Transcontinental invasions of vascular plants in Australia, an example of natives from south-west Western Australia weedy in Victoria

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Introduction

Australian native species have been exported all over the world for horticulture, agroforestry and rehabilitation usages. Regrettably, this extraordinary natural resource has also been the source of many serious environmental weeds. For example, acacias and eucalypts have become highly invasive in South Africa (Stirton 1980), where they have altered fire regimes and impacted water tables. That some of these species are from Western Australia should not be surprising given similar climates, latitude and trade linkages over the years (Marchant 1993). More likely, but less well documented, WA plants have invaded in the opposite direction into south-eastern Australia.

Some examples of species native to south-eastern Australia are discussed in other papers associated with this symposium: *Acacia longifolia* var. *longifolia*, *A. longifolia* var. *sophorae* and *Pittosporum undulatum* (Carr 2001, Coutts 2001, Mullett 2001). Other examples include *A. baileyana*, *Allocasuarina littoralis*, *Kunzea ambigua*, *K. ericoides*, *Melaleuca ericifolia* (Costello *et al.* 2000). One of the most serious is *Leptospermum laevigatum* weedy outside its natural range in Victoria and is listed as one of Western Australia's worst environmental weed threats (Ecoscape *et al.* 2000).

Carr (2001) regards *Acacia longifolia* var. *sophorae* and *Pittosporum undulatum* as two of the worst environmental weeds in Victoria, including all Weeds of National Significance except *Asparagus asparagoides*. Both have different reproductive and dispersal strategies and invade different habitats. *P. undulatum*, a bird-dispersed forest tree, has spread out of its native range because of altered management practices (Mullett 2001) and introduced birds, and has invaded remnant bushland from suburban gardens around Melbourne.

Acacia longifolia var. *sophorae* threatens coastal heathlands and heathy woodlands in south-west Victoria (Carr 2001). Likely to be bird-dispersed as well, *P. undulatum* has long-lived hard-coated seeds, not short-lived fleshy ones.

The issue of Australian native plants becoming weeds outside their range is well known to ecologists (Costello *et al.* 2000) but a difficult concept to educate others about. This short note examines the threat of this emerging type of environmental weed using examples of native species from south-west WA that have made a transcontinental shift eastwards.

The flora of south-west Western Australia

The South West Botanical Province of Western Australia (SWBP) is an important global centre of plant diversity, conservatively estimated at 2% of the worlds vascular flora (Beard *et al.* 2000). Of Australia's estimated 25 000 plant species, about 25% are found in the SWBP including approximately one third of Australia's listed rare or threatened flora (Briggs and Leigh 1996). This flora is characteristic of Mediterranean regional floras having relatively high values for species richness (5710 species), generic diversity (710 genera with an average of eight species per genus) and species endemism (79%) (Beard *et al.* 2000). Table 1 lists families and genera with high native plant species richness for the SWBP to quantify this.

Woody perennial trees and shrubs are the dominant life form in the Myrtaceae,

Proteaceae, Papilionaceae, Mimosaceae and Epacridaceae families, primarily adapted to nutrient poor soils (Beard *et al.* 2000). Other important families such Asteraceae, Orchidaceae and Stylidiaceae are dominated by annuals and herbaceous perennials and more prominent in lower rainfall areas of the south-west.

The significance of this in a discussion of native species as weeds in Australia is to illustrate the relative potential threat of such a rich and diverse regional flora.

Western Australian native species recorded as environmental weeds

Western Australian native species are recorded as weedy outside their natural range within WA and more specifically in the south-west around metropolitan Perth. At least 35 taxa have been recorded as environmental weeds, particularly in urban bushland reserves where they have escaped from amenity planting's (Keighery 2001). An additional 8 species with a more cosmopolitan distribution are considered to have native and 'non-native forms'.

A number of native species from the SWBP of WA have been recorded in Victoria (Table 2).

Table 1. Species-rich families of native vascular plant including examples of species-rich genera recorded for the South West Botanical Province of WA (from Beard *et al.* (2000)).

Top 15 Family	Top 10 Genus	No. of species
Myrtaceae		807
	*Eucalyptus**	254
	Melaleuca	106
Proteaceae		681
	Dryandra	91
	Grevillea	182
	Hakea	93
Papilionaceae		424
	Daviesia	90
Mimosaceae		398
	Acacia	397
Asteraceae		263
Epacridaceae		187
	Leucopogon	104
	Verticordia	93
Goodeniaceae		180
Cyperaceae		164
Orchidaceae		167
Stylidiaceae		154
	Stylidium	146
Poaceae		141
Rutaceae		120
Chenopodiaceae		118
Liliaceae *sens. lat.*		111
Sterculiaceae		99

*Excluding the bloodwoods (*Corymbia* spp.).

These taxa are all trees and tall shrubs, with the exception of *Sollya heterophylla*, which is a creeper. This species appears to fill an ecological niche in coastal woodlands in the same way as another invasive creeper *Asparagus asparagoides*.

This small number of species represents a very small percentage of Victoria's alien flora of over 1000 species. Why is this so? Explanations as to why so few Victorian weeds are of WA origin is speculative, but there are several useful reasons worth discussing. Firstly, we understand enough about predicting the distribution of native species to understand that climate is the major factor, particularly seasonal temperature and rainfall (Gioia and Pigott 2000). The south-west of Australia belongs to a particular global climatic type known as Mediterranean, characterized by dry summers and relatively wet winters (Beard 2000). This climate type is also found in SW Cape region of South Africa, California (USA), Chile and Italy. South-eastern Australia has a temperate climate with rainfall more evenly distributed throughout the year. Despite this, there is an area of matching climate in western Victoria, adjacent to South Australia (J. Weiss personal communication).

Secondly, it may be that relatively few species from the SWBP of WA have been introduced to Victoria, even during the 1970s when there was a surge of interest in Australian native plants in horticulture. It appears more likely that some of the most popular species utilized around Melbourne have successfully naturalized through a combination of opportunity and suitability.

Finally, the identification of WA native plants as distinct from Victorian native species is critical. It could be assumed that populations of recently naturalized and spreading WA natives go unnoticed through lack of knowledge. This compounds the existing problem that weeds in Australia are generally under-collected (Pigott 1999). Important locality information and correct identification underpins the rapid response required to eradicate new potentially serious plant invasions.

These factors are probably more important than the size or proximity of the regional flora of origin. Is the biggest threat from genera with high numbers of species? Certainly there are many serious environmental weeds from the *Acacia*, the largest genus in the South West Botanical Province (Table 1). *Acacia cyclops* and *A. saligna*, which cause serious environmental impacts in South Africa, are good examples. With long-lived seed, wide tolerance of arid and saline soils and adaptations to fire, *Acacias* should be regarded as a serious threat, mostly from trees and large shrubs such as the species mentioned rather than smaller forms such as the grass-like *A. willdenowiana*. Eucalypts such as *Eucalyptus gomphocephala*, with similar tolerances to fire and soils can be weedy too, however their seed is readily predated by ants and so germination and establishment is less predictable than for *Acacia*. Other members of the Myrtaceae family such as *Melaleucas* and *Leptospermums* are potentially serious weeds. Examples that are invasive outside their home ranges in south-west WA include *Chamelaucium uncinatum*, *Melaleuca lanceolata* and *Agonis* flexuosa (Keighery 2001). Despite being indigenous locally, *Agonis flexuosa* has altered the structure of tuart forest near Busselton in south-west WA, contributing to poor recruitment of tuart trees and contributing to increased fire risk (Pigott 1988).

There are good examples of weedy members of another of the species-rich families, Proteaceae (Table 2). *Hakeas* such as *H. drupacea* and *H. laurena* have excellent strategies for long-term dispersal. They are bradisporous, holding seed reserves in their woody fruits until burnt

Table 2. Native species from the South West Botanical Province of WA recorded as weedy in Victoria.

Species name	Common name	Family
Acacia saligna	Golden wreath wattle	Mimosaceae
Agonis flexuosa	WA willow-myrtle	Myrtaceae
Eucalyptus conferruminata	Bald Island marlock	Myrtaceae
Eucalyptus gomphocephala	Tuart	Myrtaceae
Eucalyptus lehmannii	Bushy yate	Myrtaceae
Hakea drupacea	Sweet hakea	Proteaceae
Hakea elliptica	Bronzy hakea	Proteaceae
Hakea laurina	Pin-cushion hakea	Proteaceae
Hakea drupacea	Sweet hakea	Proteaceae
Melaleuca diosmifolia	Green honey-myrtle	Myrtaceae
Melaleuca nesophila	Mauve honey-myrtle	Myrtaceae
Oxylobium lanceolatum	Oxylobium	Papilionaceae
Paraserianthes lophantha	Cape wattle	Mimosaceae
Sollya heterophylla	Bluebell creeper	Pittosporaceae

Data from (Carr *et al.* 1992), Carr (2001) and Coutts (2001).

in a bushfire. Seed is released onto ash-beds and if timed with thunderstorms produce many seedlings. Members of the Proteaceae also have highly specialized roots for adaptation to phosphate poor soils.

However, some well-known environmental weeds such as *Sollya heterophylla* and *Paraserianthes lophantha* are from genera with few species. As already discussed it is more likely that the biological characteristics of the family predispose groups of species to being weedy. *P. lophantha* is in the same family Mimosaceae as Acacia and despite its origins in moister forest regions of the south-west has very similar reproductive strategies.

As an another example, members of the Pittosporaceae have fleshy fruit and depend on bird-dispersal. Grasses (Poaceae) have unique characteristics such as wind-dispersed seed, grazing tolerance and even allelopathy.

Moreover, some WA species-rich families such as Asteraceae, Epacridaceae, Cyperaceae and Orchidaceae have no species recorded as environmental weeds in Victoria. There are other potential invasive plants from the genus *Olearia* (Asteraceae), a common group of flowing woody shrubs in Australasia.

What can we do?

There is ongoing pressure to introduce new plants for horticulture, agroforestry and rehabilitation of saline areas. Many species from SWBP are adapted to poor soils and low rainfall making them good candidates for research into the rehabilitation of saline agricultural soils. With such a large number of species what can be done to prevent new weed incursions from WA? Natural barriers such as the Nullarbor Plain and the climatic shift are important but other barrier mechanisms are required and necessary.

Firstly, a full risk assessment is essential if a new plant is suspected of being weedy. As with exotic species from outside Australia, species foreign to a region represent an unknown threat to production and biodiversity values until its risk has been assessed. This may be difficult if little is known about the species and this is typical for much of the WA flora. There are a number of strategies currently being developed by DNRE in Victoria that will help reduce the overall risk. Firstly, removal from sale in mainstream nurseries of an agreed list of known weeds is important in recruiting business and community support for preventing spread of new and emerging weeds (J. Craw personal communication). A strategic awareness program called 'Garden Thugs' developed by the CRC for Weed Management Systems broke new ground in Australia (Weeds CRC and NIAA 1999). Although few Australian natives are listed, these projects are crucial in changing cultural perceptions about horticultural plants becoming serious weeds. Secondly, development of codes of practice for industry and government to manage and educate people in these issues. Essentially these would be steps to follow to assess the risks posed by new plant introductions so as to eliminate or reduce the chances of future weeds. Additionally where some native species are found to have valuable economic potential, for example, a salt-tolerant tree for agroforestry, breeding new hybrids using molecular techniques might provide 'safer' material for introduction to new regions. These hybrids should still be assessed for potential invasiveness.

Therefore, our best-bet first assessment for native species comes from checking whether members of the same genus or family have become weedy elsewhere in Australia.

Conclusion

There is no doubt that with opportunity many WA native species can become serious environmental weeds. However despite the impressive number and diversity of species native to south-west WA, the risks are probably the same as for other Australian native species and exotics. Measures including ID training, additional collecting and risk assessment are required to reduce the threat.

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