Can Australian native plants be weeds?

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Can some Australian plants be invasive?

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Summary

Some plant species native to Australia have become weeds when introduced to regions outside Australia in that they have major negative impacts on the biodiversity of natural ecosystems in those countries. In the same way, some native plants are invasive in natural ecosystems within Australia when they are moved from one biogeographic region to another, usually for horticultural purposes. Furthermore, some native plants, especially bird-dispersed species, may respond to changes in local environments and move beyond their indigenous range to impact on other ecosystems within the one biogeographic region. Examples of Australian plants in all three situations are given and discussed. Management of Australian plants as weeds may use some combination of classical methods of biological control, strategic herbicide application and/or mechanical removal to reduce negative impacts on biodiversity. Better knowledge of the ecology and population dynamics in the indigenous range will provide a sound basis for enhanced management of invasive populations of such plant species. Horticultural industry programs to reduce the sale, distribution and planting of those Australian plants known to be weedy will be a further way to reduce the number of plant species native to Australia with potential to become weeds. I conclude that there will be more examples of Australian plants becoming weeds as more and more species are planted in parks and gardens or used to revegetate areas adjoining nature reserves near Australian cities and towns, as well as in other countries.

Introduction

A review published only 20 years ago on the ecology of skeleton weed (*Chondrilla juncea*) in southern Australia began thus:

> "Relatively few Australian weeds are native, the widespread native shrub *Sclerolaena birchii*… being one example…, along with a group of native shrubs and trees known collectively as 'woody regrowth' weeds…"
> (p. 7, Groves and Cullen 1981).

Now, 20 years hence, the Weed Science Society of Victoria has organised a day-long symposium on the topic of whether plants native to Australia can be invasive, i.e. can they be weeds? The non-native species (those introduced from elsewhere than Australia) still represent the majority of weed species in Australian ecosystems. There are, however, more native species other than the afore-mentioned *Sclerolaena birchii* (syn. *Bassia birchii*) and the woody genera of western New South Wales that now can be perceived as weeds in some way by some people. It is thus timely to assemble information on this relatively new aspect of Australian weed science if only because of the future potential of still more native species to become weeds in Australia as well as elsewhere.

In answering in the affirmative the question posed in the title given me, I firstly wish to consider Australian plants as weeds outside Australia. I then will consider some case histories in which plants native to one region of Australia have become seriously invasive when moved to another region of Australia. Thirdly, I wish to introduce the more subtle situation in which some Australian plants indigenous to specific environments in a region may become invasive in different environments in that same biogeographic region. Finally, with seemingly more and more Australian plants becoming weedy, I shall attempt to provide some answers as to what can begin to be done to manage these regional or local invasions to better retain regional or local biodiversity.

Firstly, however, I need to define my use of the words 'native' and 'indigenous'. My dictionary gives one definition of 'native' as "born in a particular place or country". This definition means that all the plants discussed subsequently have been 'born' in Australia and as such may be considered native to the continent of Australia. Some species will be native to Australia but have an even wider distribution, e.g. *Melaleuca quinquinervia*, which extends from northern Australia into Papua New Guinea. An 'indigenous' plant species, on the other hand, can mean that it is "native *to* (the soil, region, etc.)", a sense of the word I take to refer to a specific environment or region within Australia. To clarify the differences between my use of these two words, consider a well-known example. *Acacia baileyana*, or Cootamundra wattle, is native to Australia but is indigenous to a small geographic region in southern New South Wales centred on the town of Cootamundra. The distinction in meaning of these two words will become important to a later section of this paper as well as to others in this symposium, especially those relating to *Pittosporum undulatum* (Mullett 2001) and to native weeds in Victoria (Carr 2001).

Australian plants as weeds outside Australia

Several Australian *Acacia* and *Hakea* species are major weeds of fynbos (sclerophyll shrubland) vegetation in the western Cape of South Africa. Originally, all were introduced deliberately to South Africa (via English nurseries?) as long ago as 170 years either to stabilise drift sand on the Cape flats or to act as hedge material (in the case of *Hakea* spp.) (Shaughnessy 1986). The main species of *Acacia* introduced to South Africa include *A. cyclops*, *A. longifolia*, *A. melanoxylon*, *A. pycnantha* and *A. saligna*, whilst *A. mearnsii* can be invasive in Natal, outside of the areas in which it is cultivated for tan bark production. Three species of *Hakea* are also woody weeds in South Africa (viz. *H. drupacea*, *H. gibbosa* and *H. sericea*), as is *Leptospermum laevigatum* – all of which were introduced prior to 1865 (Shaughnessy 1986). In South Africa this suite of Australian shrubs still confers some benefits to the community in terms of firewood production, but their costs in terms of conservation of biodiversity and water yield foregone are considerable. Large-scale clearing of these infestations from water catchments and riverine vegetation has commenced recently and, when integrated with some recent successes in their biological control (Moran *et al.* 1986), may overcome the deleterious effects of these Australian plants in south-western South Africa.

The value of the native tall shrub *Pittosporum undulatum* for amenity planting has long been recognised (Mullett 2001), both outside Australia as well as

within the southern Australian region. For instance, plants of *P. undulatum* were in cultivation in Britain as early as 1789 (p. 22, Elliot and Jones 1980). The species is now invasive in many countries including the Azores, several Hawaiian islands, South Africa, and especially Jamaica, where it has been since 1883 and is now regarded as a major threat to nature conservation in the Blue Mountains region of that island (Mullett 2001). The species has been introduced and planted for amenity purposes in all these and other countries. Because the fleshy fruits of *P. undulatum* are dispersed by both native and non-native birds, subsequent spread has occurred from these initial amenity plantings into adjoining natural vegetation. Attempts to control the further spread of *P. undulatum* outside Australia have not been successful as yet and classical biological control programs have yet to be instituted.

The tree species *Melaleuca quinquinervia* occurs as a dominant component of coastal wetlands of northern Australia, New Caledonia and Papua New Guinea. In its native habitat it tolerates brackish water, although occasional high (spring) tides of more saline water can kill it (B. Wallace, personal communication). The species was introduced to southern United States in 1906 as a candidate for forestry (Austin 1978) and as an ornamental tree (Anon. 1996). In the ensuing 100 years it has invaded more than 180 000 hectares of fresh-water wetlands in southern Florida. In the process *M. quinquinervia* has eliminated most herbaceous species, lowered soil temperatures and the soil water table, and hence changed the habitat for wildlife. Control of this species involves strategic application of herbicides to recently cut stumps and / or burning in the dry season. More recently, a program of biological control using several insects has begun. Other Australian species that also are weedy in southern Florida include *Casuarina equisetifolia* (Anon. 1996) and the climbing fern *Lygodium microphyllum* (Beckner 1968), both of which have a wide native distribution, including northern Australia (Jones and Clemesha 1976). Biological control of the latter species is now being investigated. Another fern, the tree fern *Cyathea cooperi*, is invasive in Hawaii, New Zealand and several other countries (Low 1999).

It is clear from these documented examples that some plant species native to Australia are invasive outside Australia. They usually have been introduced deliberately to other regions, such as Florida, Jamaica or South Africa, where currently they impact adversely on natural ecosystems in those regions. Such introductions occurred before their invasive ability was recognised. Currently, the methods of classical biological control are being used in some cases in a belated effort to limit the impact of these Australian plants on natural ecosystems outside Australia. Only in South Africa have such control methods been successful so far and then, usually only when they are combined strategically with other methods of control in an integrated system of land management.

When requests for importation to Australia of new plant material are made to the Australian Quarantine and Inspection Service the importer is required to answer a series of questions about biological characteristics of the species to be imported. One early question on the Weed Risk Assessment form asks 'Is the plant widely naturalised or known to be a weed elsewhere?' (Pheloung 2000). Following this logic, none of the Australian plants that are now seriously invasive elsewhere would have been admitted. The knowledge that some plant species widespread in Australia are naturalised and weeds outside Australia adds to the affirmative case that at least some native species will be similarly invasive within Australia.

Australian plants as weeds in different biogeographic regions within Australia

The most obvious examples of Australian plants becoming invasive outside their indigenous range are provided by species indigenous to Western Australia that have become weeds in eastern Australia, following their widespread planting in gardens (Pigott 2001), and *vice versa* (Keighery 1999). *Sollya heterophylla sens. lat.* is an example of the former category that has been widely used in horticulture in eastern Australia. If planted in gardens adjoining nature reserves it soon becomes invasive in those reserves. This species has bird-dispersed fruits that contain dormant seeds as well as being capable of resprouting after fires of low intensity. In addition to these inherent attributes of the species, it has been found to have a low level of herbivory in eastern Australia relative to that for the indigenous related species *Billardiera scandens* (Taylor 1997). The level of herbivory and / or disease incidence on *S. heterophylla* in its native range still remain to be assessed. This Western Australian plant species is already invasive on the Mornington Peninsula in southern Victoria and on Black Mountain Nature Reserve in Canberra. Another species indigenous to south-west Western Australia, viz. *Acacia saligna*, may be similarly weedy in eastern coastal Australia. Equally, *Acacia longifolia*, *Cyathea cooperi* and *Leptospermum laevigatum*, indigenous to eastern Australia, can be invasive in Western Australian ecosystems, especially in the south-western forests and coastal regions. I confidently predict that many more such cases will become apparent in the future as plant species with potential for horticultural use increasingly are moved across the previously effective biogeographical barrier represented by the Nullabor Plain.

Some species of *Acacia* indigenous to one region of Australia can be invasive outside that region. I have already mentioned the case of *Acacia baileyana* in which spread into reserved vegetation has occurred from the many sites outside its indigenous range where it has been planted for amenity landscaping. *Acacia sophorae* is a low-growing shrub of foredunes closely related to the taller species *A. longifolia*. Because the former species is able to stabilise sand dunes, it has been planted widely in coastal regions of eastern and southern Australia, sometimes beyond its truly indigenous range; these non-indigenous occurrences may be regarded as weedy (Carr 2001). In much the same way, *Pittosporum undulatum* is weedy in western Victoria and south-east South Australia where it is not known to occur indigenously (Mullett 2001).

From the above few examples, I conclude that Australian plants can be invasive within Australia just as they may be outside Australia. Australia comprises 80 biogeographic regions (Interim Biogeographical Regionalisations for Australia – IBRA). When plant species are moved outside the bioregion(s) to which they are indigenous, some of them become invasive. Furthermore, the examples I have given of invasive shrubs or low trees (e.g. *Acacia longifolia*, *A. saligna*, *Cyathea cooperi*, *Leptospermum laevigatum* and *Pittosporum undulatum*) in some Australian bioregions are known to be similarly invasive outside Australia.

Australian plants as weeds within a particular biogeographic region of Australia

Plant populations fluctuate with time and changes in environmental factors. For example, populations of *Sclerolaena birchii* can increase dramatically in central New South Wales and southern Queensland with favourable periods of rainfall that may occur erratically (Auld 1981). Seeds of *S. birchii* survive in soil through intervening drought periods until the next favourable rains arrive to stimulate germination and establishment. This species interferes with sheep grazing over large areas of central New South Wales and southern Queensland after such rainfalls. A group of shrubs native to semi-arid areas of south-eastern Australia have the inherent potential to germinate and to increase their seedling establishment in response to heavy rains and subsequent floods (Moore 1969). Such episodic events have occurred in western New South Wales twice in the last 120 years. Each

time, extensive floods east of the Darling River have triggered massive increases in native shrub establishment with a consequent decline in herbaceous cover. Livestock have less to eat and are harder to muster and hence, mature plants of *Eremophila* spp., *Heterodendron oleiifolium*, and *Senna* spp. are regarded as weeds.

Whilst we may not always know what triggers population increase in Australian plant species, populations of them are often cyclic in nature and when the populations are high for whatever reason, native species may be regarded as weeds and pose a problem to land managers. In national parks such as Wilson's Promontory, *Leptospermum laevigatum* is indigenous to the calcareous foredunes. Over the last 40 years, however, the species has moved into the inland heaths on acid sands (Burrell 1981). This apparent 'shift' in edaphic requirements for seedling establishment may be related to earlier patterns of disturbance, either because of army occupation of the land 50 years ago or because of changes in the fire regime. *Leptospermum laevigatum* thus may be just as invasive within its biogeographic region (coastal south-eastern Australia) as it is around Albany in south-west Western Australia, well outside its indigenous range.

Examples of similar shifts in population distribution outside the indigenous range but within a biogeographic region are provided by *Pittosporum undulatum* and *Acacia sophorae* (see Mullett 2001 and Carr 2001 respectively). In the former case, *P. undulatum* has invaded dry slopes in eastern Victoria whereas its natural habitat is moist gullies in the same area; in the latter, as with *L. laevigatum*, *A. sophorae* currently is invading inland heaths on acid soils in south-western Victoria whereas its natural habitat is alkaline sands of the foredunes.

The length and the magnitude of the population cycles for some Australian species usually reflect changes in environmental factors. When numbers are high, some native plants may be regarded as weeds by land managers for various reasons. Certain species of Australian plants seem especially able to respond to environmental change by increasing their population size or range. If more were known about such responses, prediction of which Australian species that may become future weeds could be refined. Australian plant species with wide environmental tolerances, as Gleadow and Rowan (1982) found for *P. undulatum* with respect to drought resistance, may well be the next environmental weeds. Such wide environmental responses may be realised naturally in the indigenous biogeographic region in a similar manner as when they are planted as horticultural or revegetation material in other Australian biogeographic regions or even outside Australia.

Management of Australian plants as 'weeds'

A few Australian plants are weeds in cropping systems, e.g. *Diplachne fusca.* This species is a normal component of the grass flora of seasonally inundated depressions in the Riverina of NSW and northern Victoria (McIntyre *et al.* 1989). When these, or areas adjoining, natural intermittent wetlands are flood-irrigated and sown to rice, *D. fusca* can become a weed of that crop because conditions in its 'new' environment are so similar to those in its native habitat. In an analogous way, some native *Haloragis* species may be weeds of cotton cropping systems (G. Charles, personal communication). In these instances, the native plants have taken advantage of the cropped environment by being pre-adapted to such conditions in the environment in which they are indigenous.

In other instances, Australian plants have taken advantage of occasional favourable seasons to increase their normally low population numbers; at these times their abnormally high numbers may pose problems for land managers, especially in the pastoral regions where they are indigenous. Apart from the strategic use of herbicides there may be little that can be done to manage such situations to minimise the impacts of these Australian plants. Shrubs of the south-eastern Australian species *Cassinia arcuata* may be weedy on land over-grazed by sheep. In this instance, however, a biological control program has been implemented using an insect to reduce the impact of this species and several other related species of *Cassinia* in northern New South Wales (Campbell *et al.* 1994). In this and some other examples, where the 'weed' is indigenous to the region, a case for 'doing nothing' may be a feasible option in which the passage of time to allow for natural succession may overcome the problem. This 'do nothing' approach, however, may not be appropriate for all native weeds. For instance, it would be inappropriate for *P. undulatum* which may alter the rate of succession in invaded plant communities towards a more simplified system, leading to a loss of native plant diversity (Mullett 2001).

For Australian plants occurring as weeds in regions in which they are not indigenous, several options for management are available, of which biological control may be the most feasible, both within Australia and outside it. In some particular cases, biological agents may be used to control populations and, thereby, minimise their negative impact on native biodiversity (Bruzzese and Faithfull 2001). For example, if more were known about the levels of herbivory on *Sollya heterophylla* in its native region of Western Australia, it may be feasible to consider introducing agents shown to be specific enough to control the same plant in its introduced region in south-eastern Australia. Usually, however, biological control programs have been used mainly for those Australian plants that are invasive outside Australia and then only if they are invasive over large areas (see earlier section). One management method to limit the number of such invasive Australian plants is for nurseries not to sell plant species known to be invasive and further, not to plant them in gardens or roadsides adjoining natural landscapes, whether within Australia or elsewhere. This recommendation applies especially to those Australian plants with bird-dispersed seeds, of which the most notorious examples worldwide are *Pittosporum undulatum* and a range of *Acacia* species.

In all cases, management systems to limit population numbers of Australian plants wherever they occur, need to be based on an adequate understanding of the species' ecology in the indigenous range as well as in the introduced range. Special attention needs to be paid to the factors that may limit population increase in the indigenous range. What little is known about the ecology of *Sollya heterophylla* applies to its introduced range (Taylor 1997) and very little is known about its ecology in its indigenous range. Only in the case of *Pittosporum undulatum* is ecological knowledge sufficient in both its indigenous and introduced range to be able to define its negative impact on native plant diversity in its introduced range (Mullett 2001). Without such information it will be increasingly difficult to justify the adoption of control methods for Australian plants to a public that has embraced enthusiastically their widespread planting in all landscapes and biodiversity regions of Australia.

As a result of the increased level of planting of Australian species in amenity landscapes, the answer to the question posed in the title is strongly positive. Some Australian plants can be invasive, whether outside Australia or within different biogeographic regions of Australia. What is more, it seems certain that the number of Australian plants that become invasive in the future will increase even more so than they have over the period since 1981 when Groves and Cullen found so few instances of 'native' weeds. The number of invasive Australian plants has increased over the last 20 years but so has public perception of the problems such native plants may pose to those ecosystems in which they are not indigenous.

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References

Anon. (1996). 'Invasive plants. Weeds of the global garden'. (Brooklyn Botanic Garden, Brooklyn, NY).

Auld, B.A. (1981). Aspects of the population ecology of *Sclerolaena birchii*. *Australian Rangeland Journal* 3, 142-8.

Austin, D.F. (1978). Exotic plants and their effects in south east Florida. *Environmental Conservation* 5, 25-34.

Beckner, J. (1968). *Lygodium microphyllum*; another fern escaped in Florida. *American Fern Journal* 58, 93-4.

Bruzzese, E. and Faithfull, I. (2001). Biological control of weedy native plants in Australia. *Plant Protection Quarterly* 16, 129-32.

Burrell, J.P. (1981). Invasion of coastal heaths of Victoria by *Leptospermum laevigatum* (J.Gaertn.) F.Muell. *Australian Journal of Botany* 29, 747-64.

Carr, G.W. (2001). Australian plants as weeds in Victoria. *Plant Protection Quarterly* 16, 124-5.

Campbell, M.H., Holtkamp, R.H., McCormick, L.H., Wykes, P.J., Donaldson, J.F., Gullan, P.J. and Gillespie, P.S. (1994). Biological control of the native shrubs *Cassinia* spp. using the native scale insects *Austrotachardia* sp. and *Paratachardia* sp. (Hemiptera: Kerriidae) in New South Wales. *Plant Protection Quarterly* 9, 64-8.

Elliot, W.R. and Jones, D.L. (1980). 'Encyclopaedia of Australian Plants Suitable for Cultivation', Volume 1. (Lothian, Melbourne).

Gleadow, R.M. and Rowan, K.S. (1982). Invasion by *Pittosporum undulatum* of the forests of central Victoria. III. Effects of temperature and light on growth and drought resistance. *Australian Journal of Botany* 30, 347-57.

Groves, R.H. and Cullen, J.M. (1981). *Chondrilla juncea:* the ecological control of a weed. *In* 'The ecology of pests. Some Australian case histories', eds R.L. Kitching and R.E. Jones, pp. 7-17. (CSIRO Australia, Melbourne).

Jones, D.L. and Clemesha, S.C. (1976). 'Australian ferns and fern allies'. (A.H. and A.W. Reed, Sydney).

Keighery, G. (1999). Predicting and preventing the West's environmental weeds of the next century. Proceedings of the 12th Australian Weeds Conference, eds A.C. Bishop, M. Boersma and C.D. Barnes, pp. 572-5. (Tasmanian Weed Society Inc., Hobart).

Low, T. (1999). 'Feral Future'. (Viking, Ringwood).

McIntyre, S., Mitchell, D.S. and Ladiges, P.Y. (1989). Germination and seedling emergence in *Diplachne fusca*: a semi-aquatic weed of rice fields. *Journal of Applied Ecology* 26, 551-62.

Moore, C.W.E. (1969). Application of ecology to the management of pastoral leases in northwestern New South Wales. *Proceedings of the Ecological Society of Australia* 4, 39-54.

Moran, V.C., Neser, S. and Hoffman, J.H. (1986). The potential of insect herbivores for the biological control of invasive plants in South Africa. *In* 'The ecology and management of biological invasions in Southern Africa', eds I.A.W. Macdonald, F.J. Kruger and A.A. Ferrar, pp. 261-8. (Oxford University Press, Cape Town).

Mullett, T.L. (2001). Effects of the native environmental weed, *Pittosporum undulatum* Vent. (sweet pittosporum) on plant biodiversity. *Plant Protection Quarterly* 16, 117-21.

Pheloung, P.C. (2000). Weed risk assessment for plant introductions to Australia. *In* 'Weed risk assessment', eds R.H. Groves, F.D. Panetta and J.G. Virtue, pp. 83-92. (CSIRO Publishing, Melbourne).

Pigott, P. (2001). Transcontinental invasions of vascular plants in Australia, an example of natives from south-west Western Australia weedy in Victoria. *Plant Protection Quarterly* 16, 121-3.

Shaughnessy, G.L. (1986). A case study of some woody plant introductions to the Cape Town area. *In* 'The ecology and management of biological invasions in Southern Africa', eds I.A.W. Macdonald, F.J. Kruger and A.A. Ferrar, pp. 37-43. (Oxford University Press, Cape Town).

Taylor, D.B.J. (1997). Ecology of the environmental weed *Sollya heterophylla* Lindl. in south eastern Australia. B.Sc. (Hons) thesis, La Trobe University.

Effects of the native environmental weed *Pittosporum undulatum* Vent. (sweet pittosporum) on plant biodiversity

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Summary

***Pittosporum undulatum* is a tall shrub or small tree, native to the wet forests of south-east Australia that is now a serious environmental weed both within and beyond its natural geographic range. This adaptable species has exploited changes in natural disturbance regimes and increased dispersal opportunities to spread from abundant ornamental plantings into remnant vegetation. Invading populations of *P. undulatum* impose fundamental changes on the composition, structure and function of affected communities. This species is arguably the most serious native environmental weed in south-east Australia. However, *P. undulatum* plays an important role in the community ecology of its indigenous habitats. The species' dual native and weedy status often complicates management of *P. undulatum* in south-east Australia, especially in its natural range where many populations are expanding. An on-going targeted approach to *P. undulatum* management is required throughout the species' current distribution.**

Introduction

Pittosporum undulatum Vent. (sweet pittosporum) is a densely-foliaged, fleshy-fruited, fire-sensitive tall shrub or small tree, native to the wet forests of south- east Australia. This species is now a serious environmental weed across a range of habitats outside its natural range in Australia (Gleadow and Ashton 1981, Mullett and Simmons 1995). Some populations of *P. undulatum* occurring within the species' natural range are also expanding their distribution and local densities in response to altered ecological conditions (Rose 1997, Mullett 1999a,b). *P. undulatum* is a serious invader on other continents and islands throughout the temperate, sub-tropical and tropical zones (Cooper 1956, Richardson and Brink 1985, Cronk and Fuller 1995, Goodland and Healey 1997).

This paper describes aspects of the process, impacts and implications of *P. undulatum* invasion in south-east Australia, with emphasis on the species' effects on native plant biodiversity.

Distribution

The natural geographic range of *P. undulatum* extends seawards of the Great Dividing Range east of Westernport Bay, Victoria, north to the New South Wales-Queensland border region (Figure 1). *P. undulatum* occurs as a natural component of many habitat types throughout this area, but is mainly associated with wet