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Aussie grasses don't like to live overseas

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Abstract

When an internet search is done for Australian plants that have become weeds overseas, very few are mentioned. Eucalypts and wattles (Acacia spp.) grow very well overseas, sometimes with weedy vigour. Possums abound in New Zealand and England has colonies of our red-necked wallabies in the wild. In contrast, Australia has been very accommodating of numerous overseas plants and animals even with vigorous efforts to eradicate them in some cases.

This apparent anomaly is explored to see if we can learn something which will help us to make more informed decisions about the use and re-sowing of native grasses in our diverse landscapes. Some of our native grasses such as black speargrass (Heteropogon contortus), and kangaroo grass (Themeda triandra) are also native to other old Gondwanaland places like South America, India and Southern Africa. Others that are well regarded here and truly endemic such as curly Mitchell grass (Astrebla lappacea), Queensland bluegrass (Dichanthium sericeum) and mulga Mitchell grass (Thyridolepis mitchelliana) have not been a success anywhere overseas.

Introduction

As humans moved around the globe, they carried with them the plants and animals that fed them. They also repatriated to their homelands plants and animals that seemed useful or interesting. So the biological 'pot' was regularly stirred and Australia was the last continent to experience this, starting late in the 18th century. Speed of change in Australia was very rapid, facilitated by rapid transport. Our native plants and animals were exported regularly, either deliberately or unintentionally. However, the macadamia is currently the only significant international agricultural crop from Australia and no native animal is raised commercially overseas except at cottage industry scale.

Some Australian plants have naturalized overseas (Global Invasive Species Database 2006) and many are listed as weeds under the definition that emphasizes non-nativeness (Randall 2002). When inspecting those weed lists I was struck by the lack of Australian grasses. Why is it that many other flora and fauna families can adjust to overseas environments while so few of our 800-odd endemic grasses can? I have checked many overseas weed lists and found only a few Australian grasses (Table 1), most being pan-continental species like blady grass (*Imperata cylindrica*). Even the expansive 18,500+ name list by Randall that includes endemic plants as weeds within Australia does not list many of our grasses as serious weeds.

Why are perennial grasses listed so stridently in Australian and overseas literature as potential weeds (NSW Parks & Wildlife 2003) and yet our native grasses do not contribute? They come from an acknowledged tough environment by world

Table 1. Endemic Australian grasses that appear in overseas weed lists and major regional floras. (Note - endemic here means native to Australia only)

Status	Genus	species	Listing Country	Reference
Weeds				
	nil			
Naturalised but not weedy	*Chloris*	*truncata*	Southern Africa	Gibbs Russell *et al.* 1991
	Aristida	*contorta*	Southern Africa	Gibbs Russell *et al.* 1991

Note: No endemic Australian grasses were found in the following weed lists –FAO Weeds Database (2007); Global Invasive Species Database (2006); Invasive.org (2007); SANBI (2007); Weber & Gut (2005); Weeds Australia Database (2007); Xie *et al.*, (2001)

standards (Ellis 2005). Pan-continental grasses such as kangaroo grass (*Themeda triandra* Forssk. = *T. australis* (R.Br.) Stapf), black speargrass (*Heteropogon contortus*) and blady grass grow here too as well as in Asia, Africa and South America. Why haven't the Mitchell grasses (*Astrebla* spp.) and wallaby grasses (*Austrodanthonia* spp.) boomed in Texas, Queensland bluegrass (*Dichanthium sericeum*) in India and *Austrostipa variabilis* in Argentina? What factors could mitigate against our native grasses persisting or finding suitable niches overseas?

Climate

Australia has a range of climates that according to Köppen (1936) and Papadakis (1975) are, fundamentally, found in many other parts of the world. Most of Australia lies between 10 and 44 degrees latitude, a zone shared with a large proportion of Africa (north and south of the equator), much of South and Central America, southern Europe and the Middle East. We do lack truly equatorial climates, very high alpine country, tundra and proximity to freezing polar land masses from which prolonged freezing winter weather is derived. Thus most Australian grasses have no published requirement for vernalisation (a lengthy period of cold temperatures) to induce flowering. Our soils rarely freeze when moist so our grasses could lack the adaptation needed for that in the mid-latitudes of the northern hemisphere. Buffel grass (*Cenchrus ciliaris*) distribution in the USA is limited by this (Stait *et al.* 1998).

Leafy grasses are found most often in treeless grasslands and grassy woodlands, so high rainfall environments that grow dense forest would probably not be a suitable environment overseas. Nonetheless, riparian belts within such broad vegetation types would seem to offer similar habitats, be it for channel millet (*Echinochloa turnerana*) in arid climes or basket grass (*Oplismenus aemulus*) in coastal wetlands. We have classic Mediterranean and monsoonal climates in the south and north respectively, so opportunities should exist for weediness in equivalent overseas climates and micro-sites.

However, the physiological adaptability of plants to particular stresses can never be known for certain until the test has been made. My own experience is that potted subtropical grasses exposed to the Welsh winter, including days of snow, produced unexpected results. Mulga Mitchell grass (*Thyridolepis mitchelliana*) and African lovegrass (*Eragrostis curvula*) survived while buffel grass, wool grass (*Anthephora pubescens*), mulga oats (*Monachather paradoxus*), wiregrass (*Aristida armata*) and *Schmidtia pappophoroides* died. The survival of African lovegrass was not completely unexpected as races of it come from high altitudes in the Drakensburg ranges but mulga Mitchell was a complete shock. It is a C_3 grass that survives radiation frosts (but with burnt leaves) but it grows in arid Australia where the frozen soil and snow cover in winter that it survived is unheard of.

Daylength effects

Because our latitude, and hence daylength span in summer and winter, is the same as in many overseas lands, daylength control over flowering and general adaptation in such places should be within the range that occurs in Australia. So flowering, and hence potential seed set overseas, should not be limited by this factor. This is the opposite to what I have observed of some overseas grasses in southern Queensland (26°S) where short daylength induces crown dormancy in many North American grasses such as *Andropogon hallii*, *A. gerardii*, *A. scoparius*, *Bothriochloa ischaemum*, *Bouteloua gracilis* and *B. curtipendula*. The result is that rain in autumn and early spring is not used for growth and they compete poorly with grasses that can grow on rain at almost any time of year, e.g. Queensland bluegrass, paspalum (*Paspalum dilatatum*) and kikuyu (*Pennisetum clandestinum*). Queensland bluegrass and many wiregrasses (*Aristida* spp.) are insensitive to the direction of daylength change also.

These exotic grasses also have a well-defined flowering time and, if there is no soil moisture for several months around that time, then they do not flower that year. For grasses with a very transient seedbank this is a major potential problem. Unpredictable seasonal rainfall is a hallmark of much of Australia between 20 and 35°S, so our grasses from those regions would mostly lack strong environmental controls over their flowering, apart from soil moisture, if grown overseas at similar latitudes. Maybe this is a disadvantage if sudden polar freezes move in when they are actively growing.

Soils

Australian soils are traditionally rated as infertile (Beadle 1966) and many are, but some grassland soils such as Mitchell grass and bluegrass downs are quite fertile. Our coastal alluvial soils are as fertile as many overseas alluviums. The soils of southern Africa are just as infertile as many of ours. What we lack is recent, basic volcanic soils and glacial till that provide raw minerals for decomposition such as we find in the northern hemisphere and in volcanic belts around the world, e.g. New Zealand. We do not have many loess soils that are so common in China, Central Asia, North America and even New Zealand.

Many of our soils are more saline than those in overseas places like southern Africa, Europe and Southeast Asia but not as saline as much of Central Asia. Maybe that adaptation mitigates against competitiveness/weediness when our salt-adapted grasses are trialed overseas. Some, like *Diplachne fusca*, have been chosen for testing in salty irrigation areas in Pakistan (Sandhu *et al.* 1981) but have not apparently become weedy. Perhaps our low phosphate-requiring grasses are out-competed by those that are adapted to utilize higher levels of available P. Many Australian soils have very low levels of carbonates compared to overseas areas but we do have some limestone-derived soils (Hubble *et al.* 1983). I am fairly confident that a lack of acid soils in arid environments overseas has prevented mulga (*Acacia aneura*) from being more widely used as a fodder shrub.

Landform effects

We have very few areas where high water tables provide year-round water to perennial plants and so do not have many grasses adapted to such conditions, as found in central Europe. Nor do we have really high mountain ranges which can produce such dramatic climatic effects as seen in Asia, New Zealand and the Americas at similar latitudes. Thus we do not have the regular spring thaw waters to provide a reliable growing season that much of the rest of the world experiences in otherwise fairly low rainfall areas. *Poa* spp. and other grasses on the fringes of the Kosciusko region might have those genetic traits but they have not appeared in statutory weed lists.

Palaeontology

Our land and its pastures have traditionally been excused for their failure to stand up to heavy grazing on the basis that they had no large endemic herds of hard-hoofed animals grazing them (Robin 2003). This assertion has some credence although the hard hooves seem incidental to me compared to the biomass of herbivores, the continuous nature of grazing and the early ignorance of the real climate limitations. Kangaroo toenails make large indentations in soft or wet soil as they hop along and many other marsupials are great diggers and root eaters. Many weeds find their niche in roadsides and conservation areas where grazing pressure is low (Fensham & McCosker 2000; Stevens & Ayres 2002) and so our grasses would have that limitation lifted if they had serious weed potential.

Fire tolerance

Fire is often cited as a major driver of weedy grass invasions (D'Antonio & Vitousek 1992; Noble *et al.* 1997) and Australia is classically listed as a land where fire is an integral part of the landscape; where plants and animals have evolved in its presence (Pyne 1991). So overseas places where fires abound such as Mediterranean regions and where fire is blamed for consolidating the invasion of weedy grasses, e.g. California, should be suitable for our Mediterranean zone grasses on that basis. However, our Mediterranean climate areas had much of the land covered by forest, scrub or heath where few grasses traditionally exist, e.g. SW Western Australia and mallee lands. It still begs the question, why have our perennial *Poa*, *Austrodanthonia* and *Austrostipa* species not shown weedy tendencies?

Disease tolerance

Are our grasses very susceptible to pests and diseases that are endemic to other countries? They could be but then again, lack of natural predators and diseases is often used to explain why exotic plants explode in a new country when first introduced (Bock & Bock 2002). I have seen the converse in southern Queensland where introductions of perennial *Agropyron* and *Elymus* species have been decimated by rusts in field nurseries after establishing quite well. Perhaps it is just a timeframe thing as happened to Townsville stylo (*Stylosanthes humilis*) in the 1970s when anthracnose finally decimated it.

Land use and intensity of cropping

It seems reasonable to suggest that weedy Australian grasses would not thrive overseas in highly populated or cropped areas, such as China, India and the Middle East. The possession of robust subterranean crowns or stolons or rapid, prolific seedset would be essential for that to happen. Rhizomatous and strongly stoloniferous grasses are quite rare in endemic Australian grasses. Golden-beard grass (*Chrysopogon fallax*) is moderately rhizomatous and tableland couch (*Calyptochloa gracillima*) is strongly stoloniferous. Prolific seed set is common, eg. the lovegrasses (*Eragrostis* spp.), button grass (*Dactyloctenium radulans*), small burrgrass (*Tragus australianus*) and some *Poa* and *Aristida* species but many of those have seeds with limited dormancy to withstand close attention to hand weeding. Button grass is an exception but it does not rate a mention as a weed overseas while its relatives such as *D. aegyptium* are sometimes regarded as weedy (West & Nabhan 2002).

Short-lived seedbanks are common globally for many perennial grasses (Orr 1998) but there are enough amongst our natives with significant levels of seed dormancy for them to be a potential source of weediness overseas and here in Australia. On cropping land, spring grass (*Eriochloa pseudoacrotricha*) can be a weed and so too can granite lovegrass (*Eragrostis leptostachya*) (Wilson *et al.* 1995). Perhaps it is a case of lack of sheer biomass to enable the plants to impose themselves on surrounding vegetation overseas as can happen with sown pastures. If our grasses did not attract sufficient enthusiasm amongst overseas pastoralists that they planted large areas in many regions over many years then this impetus towards weediness may not have arisen, as has happened with buffel grass and green couch (*Cynodon* spp.) in Australia.

Terra nullius mindset

Perhaps our native grasses have traditionally been rated so poorly internationally that plant collectors have avoided them. Other groups like the eucalypts, wattles, banksias and daisies have gained international attention but in the case of the daisies and other forbs, intractable germination problems have been a disincentive to widespread use (Langkampf 1987). If the seeds are not readily germinated then botanical prospectors tend to lose interest unless the plant has really valuable traits. Thus the chance of having numerous nodes for release/infestation is very low outside of such a plant's homeland.

Amongst our grasses, Trumble (1927) down-graded our wallaby grasses (*Danthonia* spp.) because they were unresponsive to superphosphate. Many others were tried by the Commonwealth Scientific & Industrial Research group (McTaggart 1942) and many were exchanged with overseas groups in the USA, Southern Africa, Kew (UK) and elsewhere. Searches of current databases of germplasm centres around the world show few Australian grasses on their lists and with small numbers of accessions held (GRIN 2007; SINGER 2007; AusPGRIS 2007). In the 20th century up to the 1980s, it was uncommon for Australian plant evaluation trials to include native species as some sort of control or standard. Hence the Aussie mindset was apparently one of regarding the natives as inferior AND not worth trying to improve or to utilize better. I have attempted to find cultivars of native grasses for abandoned cropping land in southern inland Queensland but with very little success. Desert bluegrass (*Bothriochloa ewartiana*) has been the best so far but it has no weedy traits here and might just pass a weed risk assessment.

Conclusions

There is no obvious answer to why endemic Australian grasses rarely rate as weeds overseas. Serious grass prospectors would only occasionally see them growing vigorously AND in a situation that would appear similar to some overseas land. Since organized collection missions have been run by UN groups there has been a greater awareness of the potential for accidental weed releases, so the range of Australian material collected and exported overseas has probably been quite limited. Also there have not been many decades for an Australian grass escapee to gain a strong foothold overseas and become a listed weedy plant. As well, European countries place little emphasis on whether a weed is truly native or not because the time over which it possibly spread can be.

measured in centuries and thus reliable
records are limited

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