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NATIVE TREES: THE VALUE OF SELECTION

G M Moore, Principal, Burnley College, University of Melbourne

ABSTRACT

Once again there has been a debate about the virtue of using native versus exotic trees in urban landscapes. The debate ignited by issues related to drought, fire and sustainability has been fanned by the desire to develop an Australian landscape that both reflects, and is part of the Australian national identity. However, the fact that there is a debate at all is a testimony to the level of ignorance of native tree species, and the failure to properly select and breed native trees for urban use.

To achieve the full potential offered by the selection and breeding of native trees, the concept of locally indigenous tree populations must be fully understood and exploited. The breeding biology and gene pools of tree populations must be characterised, and species properly bred and selected against the criteria set for urban trees. The use of locally indigenous native trees will be one of the keys to attaining sustainable urban landscapes, and maintaining biodiversity over the medium to long term. This is a necessity rather than a luxury in this era of increasing environmental concern.

INTRODUCTION

It is both interesting and disappointing that a debate about the use of native or exotic tree species in Australian urban landscapes continues. Passions and emotions run high when choices have to be made about tree selection for prominent public open spaces and streetscapes, and proponents from both sides fiercely defend their own selections and criticise those of the opposition. The debate illustrates how important trees are in urban landscapes, and that they clearly impact upon the national identity (Flannery, 2002).

Because trees are so large and long-lived, the decision about the right tree to plant is an important one, and well worth the debate. The community will invest significant money in the management of the specimens for decades and even centuries, so that the trees become assets of the whole community, and their individual values can be measured in the tens, if not hundreds of thousands of dollars. Their sheer size also gives a sense of scale to built structures, the importance of which is magnified by the presence of multi-storeyed dwellings, and large numbers of utility poles and signs. This also adds to the communities perceived value of trees, as it reminds people of the human condition and the need to relate to the broader environment.

In Australia the ‘liveability’ of the major cities is often associated with the impressive parks, gardens, streets and boulevards, which have largely resulted from the involvement of horticulturists in urban planning over a century ago (Spirn, 1984). These have contributed to the design of many Australian cities, especially those developed in the second half of the 19th century, and constitute a legacy that has been enjoyed by generations since (Moore 1996). Many of these landscapes have been dominated by exotic species that are now reaching maturity, and in some instances senescence.

A CONTEXT FOR TREE SELECTION

Significant parts of South Eastern Australia are currently experiencing the seventh successive year of below average rainfall. It is probably the worst drought in the region's recorded history. It is not an acute drought like those 1982-3, or earlier decades, which tended to impact on a particular year, but were then over and soon forgotten. Rather this is a prolonged or chronic drought, which is affecting mature trees that have survived for 100 years or more. Both exotic and native are showing signs of severe stress, and in some cases major decline and death.

The stress of drought and its impact on natural and created landscapes is further compounded by recent major bushfires that have altered landscapes in Sydney, Canberra and various parts of Victoria and South Australia. Questions are asked about the interactions between the fires and vegetation, and on the contribution that the type of vegetation has on the occurrence, spread and behaviour of fire. Consideration should also be given to the processes of recovery after fire.

There is salutary lesson in what is happening. This may be the worst drought on record, but our records go back little more than a century. Such droughts may be a regular occurrence every 150-200 years, and so many of the exotic species may not be suitable for use in our landscapes over the longer term. Furthermore, fire is part of the environmental conditions experienced in the southeast corner of the continent, and should be one of the factors taken as a given in managing vegetation in any landscape, particularly on large tracts of public open space, or the urban fringes of cities.

These severe environmental conditions raise the importance of appraising our own native species of trees for use in urban landscapes. Droughts and fires, along with edaphic factors such nutrient status or soil structure should not be considered rare or unusual. They are natural, persistent and recurring components of the Australian environment and so must be accommodated in plant management strategies. Native specimens have evolved for thousands, and in many case millions, of years under environmental regimes of floods, fires, droughts, winds, soil conditions and pests and diseases that are characteristic of the Australian continent (Table 1). These evolutionary pressures have resulted in the development of adaptations in many native species that maximize their potential for survival and success under these conditions. It is the responsibility of professional plant managers to identify these adaptations, understand their implications and to use them in the selection and maintenance of trees in Australian landscapes.

EXOTICS AND NATIVES: THE BASIS OF CHOICE

While Flannery (2002) demands the use of native species in the development of a typically Australian landscape, other criteria for tree selection can be validly applied. The old horticultural adage of 'the right tree in the right place at the right time' is a sound one, and at its core it requires the use of the best tree to meet the horticultural and landscape objectives that are intended. In the past, exotics were often chosen because their biology and aesthetic performance in urban environments were well understood. In some landscapes the continued use of exotics would seem sensible. In new landscapes the use of native species would seem sensible and farsighted. In good horticulture and landscape design, there should be no place for simplistic dogmatism.

In the past, it has been difficult to justify the choice of native species for difficult urban situations, when there was relatively little scientific information about their likely performance. The adaptations of native species to the Australian environment have long been

known from a botanical ecological perspective (Table 1), but how they would perform against horticultural criteria in adverse urban environments was unknown. Furthermore, many of the native plantings of species such as Blue Gums, Paper Barks, Grevilleas, and even Bottle Brushes, that were undertaken in the 1970s, had failed, and as a consequence the reputation of native trees for urban use was tainted.

However, many of the adaptations to drought, fire, grazing and poor soils can be seen as general stress adaptations. Their existence would suggest that such trees should have the capacity to cope with stresses in general that would include the stresses that they are likely to experience in urban and regional landscapes. Under standing these adaptations should be useful in informing research into and selection of native trees for specific urban use.

TABLE 1: Some of the adaptations of native trees to Australian environmental conditions that should be considered for selection of urban trees

- Sclerophyllous leaves
- Lignotubers and lignotuberous shoots
- Epicormic buds and epicormic shoots
- Fire adapted fruits and regeneration mechanisms
- Flooding tolerance
- Capacities to withstand lengthy periods of waterlogging
- High tolerance to grazing, especially from insects
- Protective bark
- Efficient internal nutrient cycling
- Presence of allelopathic agents
- Capacity to cope with nutrient deficient soils
- Adaptations to facilitate nutrient uptake
- Appropriate mycorrhizal associations
- Flanged trunks and shallow root system
- High levels of stomatal control and water regulation

Furthermore, many of the adaptations that Australian native tree species possess, or are assumed to have, do not necessarily benefit their growth and persistence in urban environment. The assumption that native species were automatically and naturally well adapted to drought is simply fallacious. Some native species such as the River Red Gum, and various Melaleuca species, have little capacity for stomatal control and can be excessive water users. Planting such species in urban environments on the premise that they will survive drought, or use less water in comparison with exotic species is erroneous. Clearly the biology of the species whether native or exotic has to be understood and informed choices made.

This is not an argument in support of exotics over natives, but quite the contrary. It is an argument in support of knowledge of Australian species, so that appropriate choices can be made. Such informed choices should see native species used successfully even in the most difficult of urban landscapes. Failure to understand the biology of native plants will see them planted as part of an ideology that is almost certain to lead to spectacular failures that would see the cause of planting native trees in such landscapes put back decades. It would be a repeat of past mistakes, but with out the justification of ignorance at the time. There is

sufficient research and knowledge available now to indicate future directions in tree selections and breeding.

CHOICES FOR SELECTION AND BREEDING OF TREES

The first attempts to breed landscape trees in the modern era date back to the early 1900's, although some species like elms and plane trees had been implicitly bred and selected for centuries. Many of these early attempts were aimed at developing trees that were pest or disease resistant (Harris 1992). The criteria used in these selection and breeding programs, related to inherent properties of the trees and their capacities to cope with certain pests, diseases and environmental stresses (Table 2)

TABLE 2 Characteristics used in early tree selection and breeding programs (after Harris 1992)

CHARACTERISTIC	ASPECT FOR SELECTION
Inherent Characteristics	Growth habit and size
	Leaves , flowers, fruit and bark
Rate of Growth	Fast growing
	Slow growing
Wood Strength	Capacity to withstand wind and storm events
Rooting	Root architecture
	Likelihood of root damage to hard landscape
Environmental Adaptations	Climatic adaptations
	Edaphic adaptations
	Water relations – drought, water logging
Pest/Disease Resistance	Selection for pest resistance
	Selection for disease resistance
Stress Resistance	Tolerance of winds and storm events
	Tolerance of pollutants
Longevity	Longer life spans under urban conditions

Until relatively recently, knowledge of native trees in terms of their horticultural characteristics has been relatively poor. There is an excellent forestry literature concerning the growth of many native species of economic importance to the timber industry. Some of this information is relevant to growing trees in urban landscapes, but it is not enough, and as a consequence exotic species were often recommended for difficult urban landscapes.

Over the past few years, however, this situation has changed. The work of Williams (1996) on the *Lophostemon confertus,* Smith (1997, 2001 a and b) on certain exotics and *Corymbia maculata,* Bone (2002) on *C. maculata* and Looker (2001) on *Tristaniopis* species has demonstrated the diversity that exists within populations of native tree species, which can be utilised in selecting trees for urban use. These researchers all have a connection in some way with Burnley College, but there are others in various States and research institutions pursuing similar goals. The combined work of these researchers greatly expands the opportunities for appropriately selecting, within the range of native tree populations, for traits that suit specimens for urban landscape use.

Smith *et al's* (2001a and b) work has shown that *C.maculata* has a root system that shares many of the characteristics of *Ulmus* and *Platanus* species in coping with compacted and water logged urban soils. The performance of *C.maculata* under the difficult site conditions

modelled was comparable with those of these famous and widely used exotics. Smith's work reveals that *C.maculata* has a root system that is comparable with those of the two most widely planted exotic trees in the world. The conclusion is that *C.maculata* has the potential to be a great urban tree, not just in Australia, but worldwide.

In a similar way Williams (1996) demonstrated that different populations, or provenances, within the species *Lophostemon confertus* were suited to different urban environments. His work demonstrated that there was considerable variability within the population and that it was not good enough just to select the species. A choice had to be made about the characteristics from within the species that were required, and then a particular seed source specified for the origin of specimens, which possessed these traits. He also suggested that different types of specimens would be appropriate in different geographic regions of Australia.

While it has been important to understand the nature of the root systems of native specimens, Bone (2002) studied characteristics of the roots system and canopies of *C.maculata*. Her investigation rated the canopies of different populations of the species in terms of their arboricultural performance. Once again she demonstrated that there was considerable variation within the population and that careful decisions about seed source and origins of specimens for use in urban landscapes had to be made. She also investigated anecdotal reports that spotted gum was prone to co-dominant stems and the excessive shedding of branches. She found that some populations were more likely to be co-dominant (or V-crotched) than others, and to be prone to shedding, but that by selecting seed from appropriate populations these traits could be minimised.

These important studies, amongst many others, demonstrate that native species have the potential to be widely used in difficult urban landscapes. They show that by appropriate selection and breeding, native trees are comparable in their biology to some of the most widespread and best known exotic urban trees. Clearly there is a broad pallet of native species from which to choose, but research work on their horticulture and arboriculture in an urban context must underpin their choice.

Planting native species without consideration of their horticulture and arboriculture properties and without the proper research base will doom many to failure. Uninformed use of natives comes at a high cost, which will put their reputation as street trees back for years to come. Properly bred and selected, their successful use in urban landscapes for the future would seem assured.

INDIGENOUS TREES: A FRAMEWORK FOR DECISIONS

In many landscapes, the aim is to re-establish native vegetation on significantly degraded sites. Often it is hoped that at least some functional elements of the original community of plants can be re-established, or that species originally associated with the planting site may be used as part of tree selection. In the past it was considered that any native species would do. However, now there is an aim to use indigenous, or locally indigenous trees that are specific to the particular site or location. Such trees often have adaptations that would seem to suit them ideally to the site, provided that the original site conditions are substantially retained

This raises a couple of significant issues. The first is recognition that good tree selection works at the population rather than the species level, and that even at the population level there are differences, which may be significant to tree selection for a particular site. Some of this intraspecific variation has been described by the provenance concept that is widely used in forestry, and the ecotype concept of ecology. However, these terms are not synonyms with

each other or the concept of “locally indigenous”, which is widely used in horticulture, revegetation and habitat recreation.

Questions of “When is the use of locally indigenous plant material is important?”, “How is the term locally indigenous defined?”, and “How do you make decisions for a particular species about what is an appropriately “locally indigenous” plant?” are important, but often overlooked. However, the debate is a significant one from a biological and ecological point of view, and can also have significant implications for the sourcing and cost of plant materials. Once again the solution comes not from the pursuit of an ideology, but from an understanding of the biology of the tree and its effects on the ecology of the species.

This decision is largely informed by understanding that the impact of locally indigenous material will depend upon the flow of genes within the gene pool of a particular population or species. If the species has a restricted reproductive biology and gene flow is necessarily limited, then the choice of locally indigenous plant material is probably essential for the survival of the specimen, and the perhaps the long term viability of the local population of that species on the site. If on the other hand, the breeding biology is open with a significant flow of genes across populations, or even across the species as a whole, then the use of such locally indigenous material may not be so important, as it may not provide any substantial increased benefit.

Understanding the significance of the gene pool of a local population of trees and the breeding biology of the remaining specimens, and the effects of planting the same or related species nearby is essential. In a small remnant population there is a significant risk of contaminating the local gene pool with genes from other sites, if specimens of the same species from elsewhere are planted and are capable of interbreeding with the local remnants. Such events are not uncommon and can seriously degrade the genetic integrity of remnant populations, especially if the number of trees is small. If such situations arise there is a genuine threat no only to the diversity of the species but to biodiversity of significant parts of Australia. There is no value in homogenizing the genes held within the gene pools of populations of trees, but there is real value in maintaining their diversity.

A VISION FOR THE USE OF NATIVE TREES IN URBAN LANDSCAPES

Many urban sites are potentially hostile to the growth and development of trees. As a consequence it is important that trees are selected that have adaptations that will allow them to cope with the urban environment. Given how little selection and breeding of native species there has been, their adaptations to natural stresses may be indicative of their capacity to cope with levels of urban stress. As Table 1 illustrates some adaptations are general stress responses, and should pre-condition some native trees to the stressful urban sites. This is sometimes described as pre-adaptation to an environmental factor. However the concept does not have real validity in modern evolutionary theory, where an adaptation only arises as a result of real natural selection pressures, but may be useful in guiding tree selection and breeding.

Australian native trees have to be selected and bred against relevant urban horticultural criteria (Table 3). These criteria must include characteristics that are identified from modern arboricultural practice and the biology of the species themselves. Consequently the list of criteria has expanded in recent years in light of the expanded research results (Williams 1996, Bone 2002, Smith 2001, Looker 2001). It is to be expected that a more sophisticated approach to these criteria will emerge as knowledge of the urban horticulture of Australian species is expanded by thorough research and the availability of hard performance data.

The common exotics that are planted are the end products of long breeding and selection programs, some of which go back thousands of years. These trees provide considerable amenity value, and have characteristics, which are both well understood and readily specified. It is no wonder that they are so widely and commonly planted! Unless better data is available on native trees species, it is highly likely that exotics will continue to be widely planted because there is such good information on them and they can be precisely specified in tender documentation.

Until native species are selected and bred to meet the objectives of urban planting and design (Table 3), the use of poor seedling grown material from unknown sources will continue with the associated risks of poor specimens, uneven growth and development, poor canopy structures, low establishment rates and high levels of failure. Debates about natives versus exotics are usually ill informed because native trees are at a considerable disadvantage due to a lack of selection and breeding that reflects a dearth of knowledge. There is no even playing field in the comparisons of exotic versus native trees, yet many people expect native trees to perform well in urban environments, without being prepared to invest in selection, or even simple data collection on post planting performance.

TABLE 3. Breeding and selection criteria for trees for urban sites.

ASPECT OF TREE BIOLOGY FOR SELECTION OR BREEDING	TREE BREEDING AND SELECTION CRITERIA
CANOPY/ABOVE GROUND	Safe canopy structure for use in urban sites
	Good crown form and foliage density
	Retains safe canopy structure in high winds
	Reduced susceptibility to sudden limb failure
	Low incidence of co-dominance (v-crotching)
	High level of water related stomatal control
	High capacity to produce callus after wounding and pruning
	Good capacity to compartmentalise
	High tolerance of regular pruning
	Capacity to cope with pollutants
	Appropriate breeding biology
	Low incidence of major limb shedding
	Good taper on major limbs
	Tolerance of common urban pollutants
	High tolerance of pests and diseases
ROOT SYSTEM/BELOW GROUND	Appropriate root structure to cope with interactions with the hard landscape
	Capacity to cope with compacted soils
	Capacity to cope with soils depleted of oxygen and moisture
	Capacity for efficient nutrient uptake in depleted soils
	Capacity to establish a good root system in soils with high penetrative resistance
	Capacity to grow in drought or water logged soils
	Low incidence of wind throw
	Well developed trunk flare
	High tolerance of pests and diseases
	Appropriate mycorrhizal associations

CONCLUSION

The failure to use native tree species effectively and efficiently in urban landscapes deprives public open space managers of the opportunity of having impressive specimens that are well adapted to the specific environmental conditions of a specific site. The use of locally indigenous native trees will be one of the keys to attaining sustainable urban landscapes, and maintaining biodiversity over the medium to long term. This is a necessity rather than a luxury in this era of environmental concern.

To achieve the full potential that is offered by the selection and breeding of native trees, the concepts of indigenous and locally indigenous tree populations must be fully understood and exploited. The breeding biology and gene pools of tree populations must be characterised, and species properly bred and selected against the criteria set for urban trees. Such trees

should then successfully meet the aesthetic, functional and environmental objectives set for their performance.

Recent fires and drought have refocused attention on the use of native trees in urban landscapes, but quality urban trees are not simply plucked from the natural reservoir, but must be the result of careful selection and breeding. It is essential that a wide and comprehensive set of breeding and selection criteria are used that include appropriate root and canopy characteristics, but also adaptations to urban stresses. In the past selection was on a narrow range of aesthetic and limited biological traits, care must be taken to ensure that in selecting native tree species the full gamut of adaptations to urban landscapes is considered.

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