The Southwest Australian Floristic Region as a biodiversity hotspot, with special reference to its trees

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In 2000, in the prestigious biological journal *Nature*, a panel of scientists published a list of 25 global biodiversity hotspots. These are areas richest in endemic plant species under significant threat. South-western Australia is included in this list, the only region of Australia so recognised. Such international attention had been a long time coming (for a comprehensive review see Hopper, S.D. and Gioia, P. 2004. The Southwest Australian Floristic Region: evolution and conservation of a global hot spot of biodiversity. *Annual Review of Ecology, Evolution and Systematics* 35, 623–650).

Botanists had remarked upon the unique and rich plant life of parts of the south-west from the time that the able naturalist Robert Brown accompanied Matthew Flinders in the 1801-02 *Investigator* expedition along the south coast. However, botanical exploration was relatively slow and limited to a few outstanding collectors until the past four decades, when a scientific renaissance has occurred. The number of native plant species in the south-west described by botanists has doubled since the middle 1960s, when 3,600 were recognised, to today, with 7,500 now listed and more to come. It is likely that at least 8,000 species of native plants occur in the Southwest Australian Floristic Region (SWAFR), with 50 percent endemic, found nowhere else.

This explosion in description of new species is without parallel for any other temperate flora, and exceeds that for many tropical floras. The SWAFR has thus been transformed from a poor relation of the other temperate floras to one of the richest, eclipsed only by the remarkably diverse Cape flora of South Africa.

Surprisingly, given their size, trees have been, and continue to be, among those SWAFR plants containing large numbers of newly described species. Indeed, the numbers of eucalypts described since 1970 has more than doubled (392 species are now listed for Western Australia), just like numbers for the entire flora. We are literally still discovering the basic botanical information for our south-western forests, woodlands and mallee, let alone developing a detailed biological, horticultural and

ecological understanding. Not surprisingly, we have a long way to go to learn how best to care for native trees and use them wisely in urban and country environments.

Here I explore some of the more interesting, unusual and perhaps poorly known aspects of SWAFR trees, looking at a sample of trees across wild habitats. I use a botanical regionalization proposed in 2004 in the above paper, featuring three botanical provinces in the SWAFR – the High Rainfall, Transitional Rainfall, and Southeast Coastal Botanical Provinces.

AMONG THE WORLD'S TALLEST IN THE HIGH RAINFALL BOTANICAL PROVINCE

Karri (*Eucalyptus diversicolor*) is the world's second tallest flowering plant, often attaining 80-90 metres, exceeded only by the mountain ash (*E. regnans*) of Victoria and Tasmania. The towering colonnades of smooth creamy-barked karri are an inspiring sight for visitors to the south coast and high rainfall country.

Perhaps less well known are the rough-barked tingles, giant trees of three species confined to the Walpole-Denmark district. Yellow tingle (*Eucalyptus guilfoylei*) is the most widespread, red tingle (*E. jacksonii*) less so, and Rates Tingle (*E. brevistylis*) least. All three are extremely narrow endemics from a global perspective, hanging on by their toenails to the highest rainfall margin of the south-coast as the continent inexorably creeps northward towards arid oblivion. Unless helped by humans, all three tingles are destined to go the way of the south-west's now fossil rainforests over the next few million years. In the meantime, we can enjoy the majesty of these ancient survivors and their associated Gondwanan relict biodiversity.

Marri or Kardan (*Corymbia calophylla*) and jarrah (*Eucalyptus marginata*) are the other forest giants of the highest rainfall country. Marri belongs to a group of eucalypts known as bloodwoods, so called because of their richly-coloured sap that oozes and trickles from wounds on the trunk. Of vital importance to the indigenous Noongar people as a medicine tree, with edible seeds, marri is also a major source of nectar, seed and insects for birds and arboreal mammals.

Jarrah is the south-west's major timber species. A tough survivor of a range of soil types, it does best on the massive laterite gravels of the Darling Range, but also attains significant dimensions in the southern forests intermixed with karri and marri.

Major understorey trees of these giant hardwood forests include karri oak (*Allocasuarina decussata*), karri hazel (*Trymalium floribundum*), Western Australian peppermint (*Agonis flexuosa*), bull banksia (*Banksia grandis*) and karri wattle (*Acacia pentadenia*). The latter represents Western Australia's (and Australia's) largest plant

genus. More than 610 wattle species have been described for the State, and the south-west contains the richest concentration of this genus on Earth.

The tall forests occupy rich loams on valley slopes and well-drained flats. The margins of swamps in this highest rainfall country supports Warren River cedar (*Taxandria juniperina*), paperbarks such as modong (*Melaleuca preissiana*), native willow (*Callistachys lanceolata*) and the highly distinctive grasstree *Kingia australis*. Occasionally waterlogged margins of creeks and rivers are home to yarri (*Eucalyptus patens*), bullich (*E. megacarpa*), and river banksia (*B. seminuda subsp. seminuda*).

Granite outcrops feature dense low-forests of many species, including yate (*Eucalyptus cornuta*), Albany paperbark (*Melaleuca croxfordiae*), oval-leafed Hakea (*H. elliptica*), relict banksia (*B. seminuda subsp. remanens*) and granite banksia (*B. verticillata*). Rare trees such as Dwellingup mallee (*Eucalyptus x graniticola* ms) are also sometimes seen on massive granite.

Coastal consolidated dunes in places have forests of WA peppermint and yate, with understorey trees such as dungyn (*Hakea oleifolia*). Also conspicuous in this environment but seen throughout the SWAFR are the arborescent grasstrees including balga (*Xanthorrhoea preissii*) and the south coastal paalak (*X. platyphylla*). These are among the most useful plants to Noongar people, offering materials to make fire, provide torches and bedding material, as well as food in the form of leaf bases and bardi grubs. Their resin is a source of reusable thermoplastic for tool making. The unique structure of grasstrees commands attention whenever seen, in the wild or in gardens or landscaping.

Yorgum (red-flowering gum , *Corymbia ficifolia*) forms low forest and woodland on deep sandy soils mainly near Walpole, with outliers at the Stirling Range and east of Two Peoples Bay along the south coast. This is Western Australia's most famous exported ornamental tree, grown from San Francisco to Cape Town. Also on these deep sands in the Walpole-Albany district are forests of a close relative of jarrah, the short stout Albany blackbutt (*Eucalyptus staeri*).

JARRAH FORESTS, THE PINEAPPLE BUSH AND SWAN COASTAL PLAIN

Perhaps because of their demanding soil environment, jarrah forests tend to have fewer tree species present than the highest rainfall tall forests. Most often, jarrah, marri and western sheoak (*Allocasuarina fraseriana*) dominate the uplands and slopes, with yarri, bullich, flooded gum (*Eucalyptus rudis*) and paperbarks along the creeks and flanking swamps. There are, nevertheless, isolated pockets of unusual trees in the jarrah forest.

Along the Darling Scarp in particular are to be found salmon white gum (*Eucalyptus lane-poolei*), butter gum (*E. laeliae*), wandoo (*E. wandoo*), mountain marri

(*Corymbia haemotoxylon*) and rock oak (*Allocasuarina huegeliana*). Also, pockets of white sand support low forest of candle banksia (*B. attenuata*), Menzies banksia (*B. menziesii*) and holly-leaved banksia (*B. ilicifolia*), with sandy waterlogged sites the haunt of swamp banksia (*B. littoralis*).

Along Caves Road in the Leeuwin-Naturaliste National Park may be seen perhaps the world's most botanically unique low forest. Scattered among the jarrah, marri and sheoak are stunning groves of pineapple bush (*Dasypogon hookeri*), small columnar-trunked plants to five metres tall, topped with pineapple-like foliage and drumsticks for flowers. Looking like something from Conan-Doyle's Lost World, these arborescent monocots belong to the family Dasypogonaceae, found only in the south-west. The precise relationships of the family remain unelucidated despite concerted efforts applied to this question in recent global DNA studies of the flowering plants. We do know that the ancestor of the dasypogons and relatives evolved about 120 million years ago, probably in the SWAFR, when dinosaurs and conifers reigned supreme. These are seriously mysterious trees of unimaginable antiquity.

The Swan Coastal Plain supports less lofty forests of jarrah, peppermint, marri, banksias, and occasional low forest stands of spearwood (*Kunzea ericifolia*) and parrot bush (*Banksia sessilis*). Perhaps the signal tree of the Plain, however, is tuart (*Eucalyptus gomphocephala*), forming forests to 40 metres tall on the west coastal limestone soils from Busselton to Jurien Bay.

Offshore, on Garden Island especially, one the SWAFR's few coniferous forests is to be found. There, Rottnest Island Pine (*Callitris preissii*) forms dense-canopied verdant stands. This was the tree described by Dutch expedition leader Willem de Vlamingh in late 1696 as forming 'scented groves of very pleasing sweetness' on Rottnest. Also striking are particularly fine specimens of Rottnest Island tea tree (*Melaleuca lanceolata*), evoking memories of hot summer days and quokkas by the roadside on Perth's major near-shore island.

BEYOND THE TALL FORESTS INTO THE TRANSITIONAL RAINFALL AND SOUTHEAST COASTAL BOTANICAL PROVINCES

Moving outwards from the high rainfall jarrah forest, the diversity of forest trees into the semi-arid wheatbelt and adjacent goldfields woodlands is remarkable. The icons would be salmon gum (*Eucalyptus salmonophloia*) and gimlet (*E. salubris*), dominating relatively fertile clay-loams of the broad valley floors, and forming dense low forests when young.

Wandoo occupies slopes of the western wheatbelt, interdigitating with the drier margins of the jarrah forest. Inland wandoo (*Eucalyptus capillosa*) occurs higher in

the subdued landscape of the eastern wheatbelt and goldfields among decomposing granite breakaways. Various mallets form handsome low forests with little understorey on flat-topped lateritic mesas for example, *Eucalyptus gardneri*, *E. argyphea*, *E. clivicola*, *E. astringens*, *E. redacta* and more. Granite outcrops support forests attaining considerable size, if long-unburnt, of rock oak, rock wattle (*Acacia lasiocalyx*), the rare sandpaper wattle (*A. denticulosa*), sea urchin hakea (*H. petiolaris*) and many understorey trees and mallees.

Caesia (*Eucalyptus caesia*), princess of eucalypts, is one of the jewels of the Transitional Rainfall Botanical Province. It is rare in the wild, a granite outcrop endemic, winter-flowering, with two subspecies. The typical subspecies is a mallee, sometimes attaining the dimensions of a modest tree 20m tall when long-unburnt. Subspecies *magna* is smaller in stature but larger in leaves, buds, flowers and fruits. With crisped red bark, silvery pendulous branchlets and leaves, and handsome pink flowers full of nectar for honeyeaters, it is little wonder that caesia is among the most widely planted ornamental eucalypts.

Another richly-coloured species is illyarrie (*E. erythrocorys*), from further north, endemic to the limestone country from south of Dongara up to the Zuytdorp National Park north of Kalbarri. Hardy and arid-adapted, this small brittle-trunked tree sprawls over rocks, attracting honeyeaters to the nectar of its golden yellow and red flowers. For coastal regions, it is a wonderful addition to any garden, and makes for a stunning display enmasse in larger areas of landscaping.

Marlocks are effuse small trees often forming dense low forests and thickets in the wheatbelt and on the southeast coastal and island granite outcrops. These distinctive south-west Australian species include Bald Island marlock (*Eucalyptus conferruminata*), moort (*E. platypus*) and coastal moort (*E. utilis*). The latter species, widely planted, has long been confused with *E. platypus var. heterophylla*, which is a hybrid from inland regions near Ongerup, well-removed from the littoral habitat of coastal moort.

Although not single-trunked trees, multi-stemmed mallee eucalypts of the SWAFR form woody vegetation indistinguishable from low forests over vast areas of semi-arid country. There are more than 200 species of mallee in the region, one of the world's greatest radiations within a single genus of woody plants. Their tough underground lignotubers, the legendary mallee roots, afford almost immortality to disturbance and disaster causing the death of above-ground plant parts. Fire, flood, grazing, frost damage, drought all are resisted by regrowth from buds protected in the lignotuber below ground.

New species of interest and value in land care and horticulture continue to be discovered. For example, on the slopes of Mt Arid, east of Esperance, in 2006, a prostrate relative of square-fruited malle (*Eucalyptus tetraptera*) was discovered. It

was named *E. sweedmaniana* in 2009. With the largest leaves recorded for a SWAFR eucalypt, and a sprawling growth form rarely exceeding a metre in height, as well as attractive red flowers and fruits, this new species has great horticultural potential. It is also one of the rarest of SWAFR eucalypts, confined to little more than a hectare in the wild, so it needs special care and management.

The Western Australian Christmas tree (*Nuytsia floribunda*), widespread in the SWAFR, is the world's largest root hemiparasite. Sister to all other showy mistletoes, *Nuytsia* is a most intriguing tree, stunning when in flower and irresistible to the botanically curious. It has a remarkably diverse host range, and is of great cultural importance to Noongar people. The characteristically arching branches, extensive edible stem suckers and divaricately branched roots are all brittle due to anomalous secondary thickening. *Nuytsia* has an extraordinary number of three to six free, well-developed seed leaves (cotyledons). Moreover, it plunders nutrients from the roots of other plants by ring-like structures each containing a sharp seccateur-like device. For botanical novelty, cultural interest and aesthetic inspiration, few trees can match *Nuytsia.*

Banksia speciosa forms spectacular thickets along the southeast coast of the SWAFR, alive with honeyeaters and honey possums feeding on nectar. Its acorn-shaped creamy yellow cones abound on the intricately branched canopies of this small tree. Like so many banksias, *B. speciosa* is declining in the wild due to the combined onslaught of dieback disease and accelerating fire frequency associated with global warming and arson. About a third of the SWAFR's rich endemic flora is susceptible to dieback disease – the world's most malignant plant pathogen wreaking havoc on biodiversity. Transmitted through warm wet soil, this oomycete girdles roots and strangles the water and nutrient supply of hosts. Gardeners, as well as conservation land managers, need to be acutely aware of soil and nursery hygiene if they wish to enjoy the horticultural delights offered by banksias and so many other genera succumbing to this insidious disease.

There are countless other small trees in the woody flora of the Southeast Coastal Botanical Province of interest to gardeners. Among hakeas, for example, the stunning royal hakea (*Hakea victoria*) is irresistible yet in gardens most often fails to reproduce its brilliantly coloured columns of scallop-shaped leaves seen in the wild. A more tractable small tree is kodjet or pincushion hakea (*H. laurina*), its pendulous branches adorned with purple and cream balls attracting honeyeaters in search of bountiful nectar.

HAVENS OF STILL UNEXPLORED ARBORESCENT DIVERSITY - A GLOBAL HERITAGE

The SWAFR's semi-arid low forests, woodlands and mallee communities are heaven for those interested in arborescent biodiversity. New species continue to be discovered

each year as less-explored corners of the wheatbelt, Great Western Woodland, goldfields and mallee are investigated. Few places on Earth except tropical rainforests offer such ongoing opportunities for discovery to those smitten by trees.

Surprisingly, even the high-rainfall southern forests also continue to reveal previously undescribed trees. Just 15 kilometres from the south coastal town of Denmark, on the granite slopes of Peepetup (Mt Lindesay), a white-barked tree 20 metres tall and up to a metre in diameter sits among the jarrah and marri in a few hectares its entire global habitat. Named *Eucalyptus virginea* only in 2004, this is a distant relictual relative of Western Australia's most colourful and attractive horticultural mallees such as mottlecah (*E. macrocarpa*) and rose mallee (*E. rhodantha*).

Although now an exceptional circumstance, that such a tall handsome tree could remain undetected and unnamed by botanists right up to the present day says a lot about how much more we have to learn about south-western forests, woodlands and mallee. These are globally significant habitats of truly unique species confined to a wet corner of an ancient arid land.

The conservation and wise use of the SWAFR's trees is in our hands. Protection through reserves continues to be a fundamental strategy, with a number of new national parks created over the past few decades. Ongoing biodiversity studies are integral, furnishing the knowledge and management approaches to ensure effective conservation. Improved methods of timber and tree utilisation are another essential strategy, adding value to products obtained from forests. There are stunning examples of the fine art and craft possible using south-western hardwoods.

We have much to learn from respectful cross-cultural studies with Noongar people, who for more than 45,000 years managed SWAFR trees and vegetation with a level of sophistication as yet unmatched. Gardeners also have a pivotal role to play. Deciding which tree to plant, in which place, is vital. Consideration of the SWAFR's rich endemic tree flora as part of the palette in urban design and rural land care is strongly recommended, offering a celebration of a unique global heritage, and making an important contribution to the maintenance of biodiversity and cultural awareness.

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