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Eucalyptus Study Group Newsletter

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Study Group Leader
Warwick Varley
PO Box 456, WOLLONGONG, NSW 2520
Email: tallowwood@hotmail.com

Membership Officer
Steve Harries
50 Nardoo Rd., PEATS RIDGE, NSW 2250
Email: abodepool@bigpond.com

Eucalyptus Study Group Website
Web address: http://asgap.org.au/EucSG/index.html

Eucalyptus Facebook page
Web address: http://www.facebook.com/pages/Eucalyptus-Trees/124249007754284?ref=hl

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Thankyou for the contributors of this issue; Rod Kent and Sheryl Backhouse.

Eucalyptus beyond Its Native Range: Environmental Issues in Exotic Bioenergy Plantations

Source: International Journal of Forestry Research, Volume 2013 (2013), Article ID 463030, 5 pages
http://dx.doi.org/10.1155/2013/463030

By John A. Stanturf, Eric D. Vance, Thomas R. Fox, and Matias Kirst

The genus Eucalyptus is native to Australia and Indonesia but has been widely planted in many countries. Eucalyptus has proven to be particularly successful in tropical and subtropical regions. Several species are also successful in some temperate regions, but problems with sudden and severe frosts pose limitations. Current plantations around the world are dominated by the "big nine" species (*E. camaldulensis, E. grandis, E. tereticornis, E. globulus, E. nitens, E. urophylla, E. saligna, E. dunnii,* and *E. pellita*) and their hybrids, which together account for more than 90% of Eucalyptus planted forests. Much of current tree improvement efforts focus on the use of hybrids and clones, and development of genetically modified Eucalyptus is already underway.

For many reasons, there is increased interest in using wood for energy, and short-rotation plantings of Eucalyptus will likely be an important source of feedstock [1]. Many Eucalyptus species have desirable properties for bioenergy plantations, including rapid growth rates and high wood density. The indeterminant growth pattern and evergreen foliage allow eucalypts to grow whenever climatic conditions are suitable. The sclerophyllous leaves of eucalypts allow them to withstand very dry conditions and may also be an adaptation to low nutrient conditions. However, the same traits that make Eucalyptus attractive for bioenergy and other bioproducts, such as rapid growth, high fecundity, and tolerance of a wide range of climatic and soil conditions, also make them potentially invasive.

The prospect of widespread planting of these nonnative species for commercial purposes in the southern United States has again arisen, prompting questions about potential environmental effects. In response, a conference was held in Charleston, South Carolina, in February of 2012 to review the history of Eucalyptus research and culture in the USA and around the world and to examine potential environmental issues surrounding their expanded introduction in the southern USA. Environmental issues addressed included invasiveness potential, fire risk, water use, and sustainability. Papers from that conference, as well as contributions from other countries that shed light on these issues, are the subject of this special issue.

Background. Two papers in this special issue summarize the history of Eucalyptus plantings in the USA. R. C. Kellison et al. discuss the introduction of Eucalyptus species to the United States while D. L. Rockwood reviews the history and status of tree improvement research activities with *E. grandis, E. robusta, E. camaldulensis, E. tereticornis, E. amplifolia,* and *Corymbia torelliana* in Florida. Significant plantings of Eucalyptus in the United States began with introductions from Australia as a result of the California Gold Rush in 1849. Eucalyptus species were introduced in the southern USA as early as 1878, but no significant commercial plantations were established until the late 1960s. Performance of selected species for ornamental purposes caught the attention of forest industry and led to species-introduction trials in 1959. Cooperative efforts by forest industry and the USDA Forest Service on genetic improvement of selected species for fiber production were successful enough to engender interest from industrial forestry companies in the upper South, who established plantations with little attention paid to species or seed source. These plantings failed, leading to more systematic evaluation of 569 sources representing 103 species over a 14-year period by the Hardwood Research Cooperative at North Carolina State University.

Severe winter temperatures in late 1983 and early 1984 and 1985 terminated this effort. Research to develop frost-tolerant Eucalyptus in other regions of the world combined with moderated temperatures across the South has fueled renewed efforts to identify frost-tolerant species adapted to this region.

Even in Florida, low temperatures are a challenge. Three 100-year freezes in the 1980s, extended cold periods during the winter of 2010–11, and the abrupt freezes of the "warm" winter of 2011-12 affected survival and growth of even frost-tolerant young eucalypts. A renewed effort to identify frost-tolerant species and genetic modifications to increase frost-tolerance that will permit expansion of the range of Eucalyptus is driven by the potential need for 20 million Mg yr^{-1} of Eucalyptus wood for pulp and biofuel production in the southern USA by 2022 [1]. If appropriate species and genotypes can be identified, as much as 5,000 to 10,000 ha yr^{-1} of commercial Eucalyptus plantations may be established in the South, most likely in the Lower Coastal Plain region of north Florida, Georgia, Alabama, Mississippi, Louisiana, and Texas [2]. Given the current effort to develop Eucalyptus clones that tolerate the weather extremes of the South, the question may not be "Should we plant Eucalyptus?", but instead "How should we manage Eucalyptus plantations?"

The potential productivity of Eucalyptus under short rotation for biomass is significantly greater than the widely cultured *Pinus* species [3–5]. Short-rotation systems in Peninsular Florida using *E. grandis* and *E. amplifolia* can produce up to 67 green Mg ha^{-1} yr^{-1} in multiple rotations as short as three years. Nevertheless, high silvicultural costs associated with establishment and management may be a barrier to Eucalyptus production in the USA. Based on experience with Eucalyptus management gained from the earlier work, Kellison et al. suggest the following emphases: concentrate efforts on soils of sandy clay loam and clay loam textures and avoid soils with imperfect or excessive drainage; keep plantations free from weed competition for at least the first two growing seasons; and develop efficient fertilizer treatments. Seedling quality for bareroot planting should have root-shoot ratios in the range of 0.6, and seedlings should be planted in early spring, but after the last frost. Container seedlings can be planted whenever there is adequate soil moisture but should be done early enough for adequate growth before frosts. With the development of proven clones, economical and rapid propagation becomes a need, with current vegetative propagules about 33% more expensive than seedlings. Weed control treatments are not well developed for Eucalyptus in the South and may be the greatest silvicultural challenge. Herbicide treatments used for pine culture are not appropriate for Eucalyptus plantations and new treatments must be developed to ensure adequate control of competing vegetation without seedling damage.

Invasiveness. Potential invasiveness was the key concern addressed at the conference and three papers in this special issue look at this from different perspectives. T. H. Booth brings a broad perspective from Australia and other countries, particularly the potential for invasiveness in frost-prone regions. D. R. Gordon et al. apply the Australian Weed Risk Assessment tool that is based on traits associated with invasiveness and experience from other countries. M. A. Callaham et al. report on a preliminary field assessment of actual escapes from Eucalyptus plantings in South Carolina and Florida. Some Eucalyptus species have biological properties that could result in invasiveness in some locations. Globally, only eight eucalypt species are considered to be invasive in some locations: *Corymbia maculata, E. camaldulensis, E. cinerea, E. cladocalyx, E. conferruminata, E. globulus, E. grandis,* and *E. robusta* [6]. A review of general experience of Eucalyptus around the world (e.g., Brazil, Chile, and Australia) and the experience from regions similar to the Lower Coastal Plain (e.g., China and Brazil) concluded that the potential for Eucalyptus invasiveness is generally low due to poor dispersal, small seeds with limited viability that require bare soil to germinate, and light demanding seedlings that do not grow successfully under closed forest or understory canopies. However, Eucalyptus invasiveness has been a particular problem in southern Africa, where it was initially introduced around 1828 and was widely planted from about 1850, more than 50 years before they were introduced into Brazil. *E. camaldulensis* is a particularly serious problem in southern Africa as it has spread down watercourses as it does naturally in Australia. It appears that the more commonly cultivated a species is, the more likely it is to become invasive, in accord with the theoretical requirement of sufficient propagule pressure before invasiveness becomes apparent.

Weed risk assessment tools based on qualitative scores that depend on biological properties and confirmed invasiveness or naturalization in one or more locations could be useful as a screening tool. High scores indicate potential for invasiveness and a need for further study in context of an overall assessment of a species' potential benefits and risks as a short-rotation woody crop. D. R. Gordon et al. selected 38 Eucalyptus taxa (species, hybrids, or clones) that had previously been evaluated using the Australian Weed Risk Assessment tool in Hawaii, the Pacific, or Florida; they found the four taxa that are currently most likely to be cultivated in the USA South (E*. amplifolia, E. benthamii, E. dunnii, and E. dorrigoensis*) to be low invasion risks. Two taxa, *E. camaldulensis and E. viminalis*, were assessed as high risks and there were two taxa needing further evaluation (*E. macarthurii and E. urograndis*). Three other taxa that have received attention are predicted to pose a high risk of invasion (*E. grandis, E. robusta, and E. saligna*). All the scores in D. R. Gordon et al. were higher than those found by earlier assessments.

In the study reported by M. A. Callaham et al., Eucalyptus invasiveness potential in the southeastern USA was assessed based on an analysis of seedlings found within and near established plantations on 3 sites in South Carolina and 16 sites in Florida. They found a small number of Eucalyptus seedlings growing in areas adjacent to established plantings in Florida where seedlings were found within and nearby to Eucalyptus plantations at 4 sites, but only two individuals were detected more than 45 m from plantation boundaries. All seedlings were *E. amplifolia, E. robusta, or E. grandis*. Their results indicated that some Eucalyptus species may naturalize (spontaneously reproduce in their introduced range) in the South but there was no evidence for invasion (reproducing and spreading long distances, i.e., 100s of m in large numbers). Surrounding intensively managed land use seemed to militate against escape; no seedlings were found in agricultural, suburban, or citrus orchard land uses. Because seedlings were found in less intensively managed areas such as partially wooded sites, they cautioned that the potential for spread into unmanaged areas should not be dismissed.

Overall, these papers indicated a limited potential for invasiveness of most Eucalyptus species under consideration for planting in frost-prone areas outside of Peninsular Florida. However, the risk of invasiveness associated with Eucalyptus may increase as the scale of culture and propagule pressure increases in the southern USA. One factor put forth to explain the limited spread of Eucalyptus in subtropical climates may be that the fungal symbionts of the species in question are not able to fruit and disperse into the surrounding soils. Another paper by M. Ducousso et al. in this special issue, however, points out that in Africa and Madagascar, diverse species of ectomycorrhizal fungi are found under Eucalyptus even though intentional inoculation has been limited to a few experimental trials.

These authors provide suggestions for avoiding or managing potential invasiveness. Keeping plantations away from watercourses and maintaining clear firebreaks should reduce the chances of escape from plantations. Interspersing Eucalyptus plantations with other intensive land uses such as pine plantations would limit the ability of Eucalyptus to spread and establish. Planting sterile genotypes or clones selected for low levels of seed production or even modified for sterility could reduce the risk of invasiveness. Short rotations reduce total flower production potential of individual trees and stands and reduce the total number of heavy seed production years. Short rotations are also characterized by intensive establishment practices that would limit the potential for individuals to naturalize. But whatever genotypes are grown (whether genetically modified organisms, clones, or otherwise), new plantations should be carefully monitored to check on seed production and ensure that the trees are not invasive. Over time, continued vigilance and robust monitoring will be needed because invasiveness potential may increase due to increased propagule pressure, climatic changes that remove current barriers to reproduction such as lack of synchrony between flowering and pollinators, and short-term evolution and hybridization that may alter plant traits and increase invasive potential.

Fire Risk. S. L. Goodrick et al. in this issue sought to answer two questions regarding the potential fire risk of widespread plantings of Eucalyptus in the Lower Coastal Plain: (1) what effect would this have on risk of wildfires? and (2) how would fire behavior in Eucalyptus stands differ from fires in commonly occurring vegetation types such as pine plantations? They provide preliminary answers to these questions based on modeling using the Fuel Characteristic Classification System (FCCS) and literature values for fuel characteristics and loads. They found that surface fire behavior in young Eucalyptus plantations differs little from surface fires in fuels common to pine forests characteristic of the Lower Coastal Plain. Eucalyptus is better known, however, for its crown fires and spotting behavior. The FCCS modeled crown fire potential well but existing models do not adequately account for potential spotting behavior of Eucalyptus. Modeling suggests that fire behavior at the stand level differs little from current conditions and points to the importance of avoiding the development of a shrub layer. Stands managed on short rotation (less than 10 years) will likely be harvested before bark shedding presents a significant spotting problem. Fire risk will likely vary with the landscape context of Eucalyptus plantations. Internationally, fires are more likely to start outside Eucalyptus plantations than inside but once a crown fire is initiated, it will spread rapidly and the potential is for more severe crown fire behavior than in pine stands. These authors recommend that future work focus on possible effects on fire risk in the landscape. As it becomes clear which species have the greatest commercial potential for widespread planting, it will be possible to better predict spotting potential and evaluate applicability of available models of firebrand production and dispersal to current and future conditions in the Lower Coastal Plain, keeping in mind the variability in wood properties of clones as noted in another paper in this issue by B. L. C. Pereira et al.

Water Use. Water use of Eucalyptus is a controversial issue, and many studies have been directed toward water use at the individual tree and stand levels with fewer studies at the landscape (catchment or watershed) level. In this special issue, J. M. Albaugh et al. review the techniques used to quantify water use of Eucalyptus plantations, provide an overview of studies in water-limited South Africa, and recommend where to concentrate future research efforts. In South Africa, WUE varies significantly among Eucalyptus clones and is not a constant characteristic of a given genotype; WUE for Eucalyptus species in South Africa ranged from 0.0008 to 0.0123 m3 of stemwood produced per m3 water consumed. W. Dvorak [7] recently reviewed studies internationally and applied this experience to understanding potential effects of planting Eucalyptus in the southern USA. Physiological studies in several countries has shown that Eucalyptus have similar water use efficiency (WUE) to other tree species. Water consumption at the stand level depends upon water availability, vapor pressure deficit, and WUE; water availability, therefore, is a major determinant of productivity [7].

Actual water use by Eucalyptus in a watershed depends on many factors including the areal extent, size, spatial distribution, productivity, and age-class distribution of planted stands. Much has been made of the effect of converting other land uses to Eucalyptus plantations. Eucalyptus has potentially higher water use and water use efficiency compared to pasture, pine plantations, and native forests but water use is much lower in Eucalyptus plantings than in irrigated crops. Studies in other countries suggest that effects of Eucalyptus plantations on stream flow may be most apparent in drier regions where precipitation is approximately equal to evapotranspiration (this point was effectively made by Walter de Paula Lima, University of São Paulo, in his talk at the conference on Hydrology studies of Eucalyptus in Brazil). Water consumption by Eucalyptus plantations will be higher in terms of percentage of water supply in drier regions but absolute water consumption will be higher in wetter region [7].

Information about resource requirements (water uptake and nutrient requirements) and resource use and production efficiencies of Eucalyptus trees and plantations, as well as stand-level measures of water quality across a range of sites, could inform landscape models. The key indicator of plantation sustainability is water balance in a watershed, not just evapotranspiration or consumption [7]. Ongoing modeling studies suggest that predicted watershed-level response to small and moderate amounts of land in Eucalyptus plantations in the southern USA may be difficult to detect. Key information needs are the potential influence of Eucalyptus plantations on isolated wetlands and potential impacts of different tree densities on hydrology. Management strategies to avoid water quantity and quality impacts include avoiding planting Eucalyptus in recharge areas and other hydrologically sensitive areas, longer rotations or lower densities, and adherence to water quality best management practices. Under current climatic and land-use conditions, the Lower Coastal Plain presents no apparent limitations to Eucalyptus plantations from a water standpoint [8]. The variability in WUE among Eucalyptus clones suggests a potential for breeding trees with improved WUE and drought resistance [7] which could be important under future climate and land uses that compete with forestry for available water [8].

Sustainability. Eucalyptus plantations in countries outside the USA are managed under the auspices of sustainable forestry certification programs, and significant variation among Eucalyptus species severely limits generalizations that can be made concerning environmental issues associated with establishing and managing Eucalyptus plantations. Environmental issues associated with use of Eucalyptus species as short-rotation woody crops in the USA South appear to be manageable with risk-appropriate strategies but merit ongoing, substantive attention and investigation. Indicators, including those related to biodiversity, are needed to support assessment of both environmental and socioeconomic sustainability of bioenergy systems, including culture of Eucalyptus. Existing indicators proposed in the scientific literature and developed by other entities could potentially be adapted for application to Eucalyptus culture in the southern US, as discussed in this special issue by V. H. Dale et al. and X. Huang et al. Studies outside the southern USA confirm that Eucalyptus forests are not “green deserts” and do support native plant and animal species. Studies of short-rotation woody crops in the USA suggest that some native plant and animal species will respond positively and others negatively to Eucalyptus plantations. Interpretation of results from studies of biodiversity response to Eucalyptus plantations will likely depend in part on the experimental comparison (e.g., agricultural land, pine plantations, mature hardwood forest, or comparable-age native hardwood forests).

Existing information about Eucalyptus culture from other countries may serve as a strong basis for hypotheses about environmental issues associated with culture of this genus in the southern USA. Environmental implications of Eucalyptus culture should be considered in the context of those associated with alternatives for fiber and energy production. V. H. Dale et al. selected a suite of 35 sustainability indicators, including 19 environmental (in areas of soil quality, water quality and quantity, greenhouse gases, biodiversity, air quality, and productivity) and 16 socioeconomic (social wellbeing, energy security, trade, profitability, resource conservation, and social acceptability) indicators. They found that some requisite information was lacking at the needed temporal and spatial scales in order to assess the potential for a successful bioenergy industry based on Eucalyptus. Nevertheless, they concluded that the sustainability issues did not differ greatly from those of other feedstocks and it is the specifics of how the industry is developed and deployed that determine environmental implications.

Economic and sociopolitical factors will heavily influence the nature of Eucalyptus culture in the southern USA. X. Huang et al. reported on a geospatial method called BioSAT (Biomass Site Assessment Tool) to identify interactions associated with landscape features, socioeconomic conditions, and ownership patterns and the influence of these variables on locating potential conversion facilities. They applied this method to estimate opportunity zones for woody cellulosic feedstock based on landscape suitability and market competition for the resource. Using a landscape competition index, they identified potential opportunity zones in central Mississippi, northern Arkansas, south central Alabama, southwest Georgia, southeast Oklahoma, southwest Kentucky, and northwest Tennessee. Their method was not specific to Eucalyptus; however it could be adapted by limiting the study area to the suitable region for frost-tolerant clones. Even though decisions about establishing Eucalyptus plantations on private land can be based on narrow economic considerations, enlightened management and certification requirements increasingly recognize the necessity of public input. Multistakeholder biodiversity conservation initiatives such as The Forest Dialogue for the Atlantic Forest, The Atlantic Forest Restoration Pact, and the Sustainable Forest Mosaics Project may serve as models for conservation planning related to Eucalyptus culture in the southern USA.

Ancient Tall Trees

By Rod Kent

Recently late one night I was unable to sleep. Turning on the radio I heard a BBC interview with David Milarch. I found his story quite amazing indeed, and I think that members of the eucalyptus group will also. He said that he had been quite a drinker. In the final analysis his kidneys and his liver failed due to his alcohol intake. He collapsed and was taken to hospital where his heart stopped and he was pronounced dead. He remembers his soul floating up to the ceiling looking down at his dead body on the operating table. Suddenly an angel appeared saying that they were going to take him off to the afterlife. David replied that he would make a deal if he could live. The medicos got his heart beating again and David came back to life. It was then that David dedicated the rest of his life to the mission given to him by the angel. What was this heavenly mission? The mission was to search out the tallest most long-lived trees and clone them. The reason for this is that these tall trees that may have lived for hundreds even thousands of years must have some genetic property that allows them to survive inhospitable climactic conditions. The idea was to clone these trees and use these clones for re-afforestation. Over the last 25 years his group has cloned some 135 species including oaks and redwoods. I refer the reader to the Archangel group's chock-a-block website for David's talk, mission statement, and cloning details. It is https://www.ancienttreearchive.org/

The Archangel's group mission dovetails into the article by Tim Entwisle, "In search of Australia's biggest tree", in the previous eucalypt newsletter number 69. In this article it is proposed to make a register of tall, living ancient trees in Australia. We could possibly see the formation of a similar group in Australia to the Archangel group in the USA. The candidate for the oldest living ancient tree archive in Australia would be *Eucalyptus regnans*, the Mountain Ash. Wikipedia gives a nonliving mountain ash measured at 132 m and a living one at 102 m. This compared to a redwood measured at 112 m and a Douglas Fir measured at 126 m high. We can see that the Australian Mountain Ash is in the running for being the tallest tree on earth. Surely these trees are worth conserving too.

The mechanism of how transpiration of huge quantities of water up from the roots to the top most leaves in these tall trees still seems to be somewhat of a mystery. The capillarity – adhesion - cohesion hypothesis has been around for about 100 years and seems the best explanation so far. The idea is that evaporation of water from the leaf stomata "pulls" the water up by supposed "negative pressure" (whatever that is). Capillarity supplies some of the lift while the water molecules adhere to the xylem cell walls and cohesion of the water molecules themselves prevents the water column itself from breaking up. This explanation of transpiration seems to me to leave a lot to be desired as no straight water column no matter how thin can apparently reach 132m in height against gravity. Transpiration is important to understand as it supposedly gives a limit to the height a tree can attain. Perhaps a botanist reading this article can give us a more convincing explanation of transpiration than the one presented here in the next issue of this newsletter.

ABSTRACT
Intraspecific diversity of terpenes of *Eucalyptus camaldulensis* (Myrtaceae) at a continental scale

Carlos Bustos-Segura , Shannon Dillon , Andras Keszei , William J. Foley and Carsten Külheim
+ Author Affiliations
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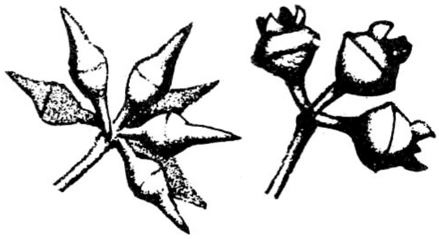
Plants show a high degree of intraspecific variation in several traits including plant secondary metabolites. This variation can be influenced by genetic and environmental factors that result in geographical structure in their distribution. By growing plants from several populations in a controlled environment, we studied variation in foliar terpenes in *Eucalyptus camaldulensis*, which is the widest distributed eucalypt, with a large range both latitudinally and longitudinally. We found that the concentration of terpenes is highly variable among subspecies. We identified four chemotypes dominated by 1,8-cineole, γ-terpinene, α- and β-phellandrene. While the 1,8-cineole chemotype is abundant in all populations, the other three chemotypes are rare in the central area and the north-east of Australia. The γ-terpinene chemotype is mainly restricted to the north and west of Australia, whereas the α- and β-phellandrene chemotypes show an opposite distribution in the north and south of the continent. The annual mean temperature and humidity of the source populations correlate with the abundance of the dominant terpenes. We also tested the effects of elevated

CO_2 concentrations on the terpene concentration and found that elevated CO_2 atmosphere reduces the overall accumulation of foliar terpenes. The results suggest that variation in terpene composition in *E. camaldulensis* can be influenced by environmental variables, mainly favouring the 1,8-cineole chemotype in arid locations.



Eucalyptus camaldulensis buds and fruit capsules. From Australia Forestry and Timber Bureau, *Illustrations of the buds and fruits of eucalyptus species*, 4th ed., 1962

ABSTRACT

Biomass Losses Caused by *Teratosphaeria* Leaf Disease in *Eucalyptus globulus* Short Rotation Forestry

Severiano Pérez , Carlos J. Renedo, Alfredo Ortiz, Félix Ortiz and Agustín Santisteban

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This article presents the results of a study that examines the loss of biomass and energy, per hectare, caused by *Teratosphaeria* leaf disease (TLD) in *Eucalyptus globulus* short rotation forestry. The 95 *Eucalyptus globulus* taxa analyzed are from seeds of open pollinated families of both Spanish and Australian origin. Tree height and diameter were measured and the crown damage index (CDI) assessed at 27 months of age. Taxa that have a certain tolerance to the disease have been identified. The taxon identified as code 283 is the one that shows lower CDI (42%) and with an average volume that exceeded 0.017 m^3 at 27 months of age. Biomass losses were determined for each fraction of dry biomass of the tree (leaves, branches, twigs and bark) based on CDI. These losses were translated into terms of energy lost per hectare, depending on the CDI. A comparison was then carried out between the productivity of *Eucalyptus globulus* exhibiting various levels of TLD severity and poplar and willow clones used for bioenergy in Europe. In our region, the results show that despite the losses of biomass associated with TLD, *Eucalyptus globulus* remains competitive as long as CDI values are lower than 56%.

Eucalypt trail finds stories in the trees

Source: http://gardendrum.com/2016/04/04/eucalypt-trail-finds-stories-in-the-trees/

By Sharon Willoughby, Royal Botanic Gardens Victoria, April 4, 2016

On 23 March 2016 the Royal Botanic Gardens Victoria (RBGV) celebrated National Eucalypt Day with our partners at the Bjarne K Dahl Trust (Dahl Trust) by launching a new trail at Cranbourne Gardens Eucalypts for your home garden. This trail uses plant labels, signage and QR codes, linked to deeper web content and video, to highlight 40 small eucalypts that are terrific for Melbourne home gardens such as the beautiful *Eucalyptus cosmophylla*. The trail contains a wealth of information about how to: select, plant and care for a small gum tree that would be ideal for your home garden.

Chris Russell (Director Cranbourne), Sebastian Chapman (Board Member Bjarne K Dahl Trust), Catherine Ashton (RBGV), Professor Leon Bren (Board Member Bjarne K Dahl Trust) and John Arnott (RBGV) with *E. cosmophylla* in full bloom. Photographer: Warren Worboys.

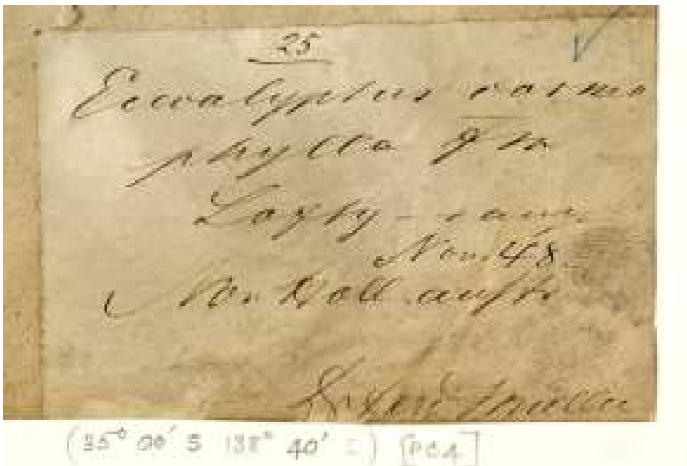
The 23 March date marks the birthday of the founder and benefactor of the Dahl Trust, Bjarne K Dahl (1898 – 1993), a Norwegian forester who worked in the Victorian forests from 1928 to 1961. Dahl developed a deep connection to the Australian bush, and as a mark of his affection, he left his estate to the Forests Commission of Victoria (later the Department of Sustainability and Environment) in order to establish a trust focused on eucalypts. A grant from the Dahl Trust has enabled the RBGV to establish the Eucalypts for your home garden trail.

***Eucalyptus cosmophylla* in flower in the Australian Garden. Grows to 10m as a single trunk for or to 5 m as a multi-stem mallee form. Photographer: Rodger Elliot.**

Eucalyptus is certainly a genus that has inspired many passionate advocates. For me the really interesting thing about gums are the stories of the people, such as Dahl, who have become enchanted by these trees especially the botanists who have sort to classify and name them over and over again as technology or our understandings of relationships within the genus have changed. Recently I met with Dr Pina Milne, Manager Collections, and Dr Frank Udovicic, Manager Plant Sciences, who both work for the RBGV in the National Herbarium of Victoria, to take a peek at the kinds of stories that are encoded on herbarium voucher specimens. The herbarium holds approximately 1.5 million dried plant, algae and fungi specimens. Each one of these voucher specimens contains a wealth of information about each species. We had a look at one of the original specimen of *Eucalyptus cosmophylla* together.

Voucher specimen, Eucalyptus cosmophylla or Cup Gum. Photograph courtesy of the Royal Botanic Gardens Victoria.

Pina pointed out to me the label on the bottom right hand corner of the voucher (see image above).
"*Look*", Pina marvelled, "*This label shows that this cutting was made by Ferdinand Mueller in November 1848 in the Lofty Ranges of South Australia and named Eucalyptus cosmophylla by him*". Mueller (1825 – 1896) was Government Botanist of Victoria from 1853 to 1896 and Director Melbourne Garden from 1857 to 1873. He arrived in SA with his two sisters from Germany in December 1847 and as this specimen demonstrates very quickly started botanising. It was amazing to me, to find myself, looking down at an original piece of Mueller's handwriting from 168 years ago. I hardly dared to breathe as the three of us bent over this old and fragile specimen, the urge to reach out and touch the ink of his hand writing was almost unbearable.



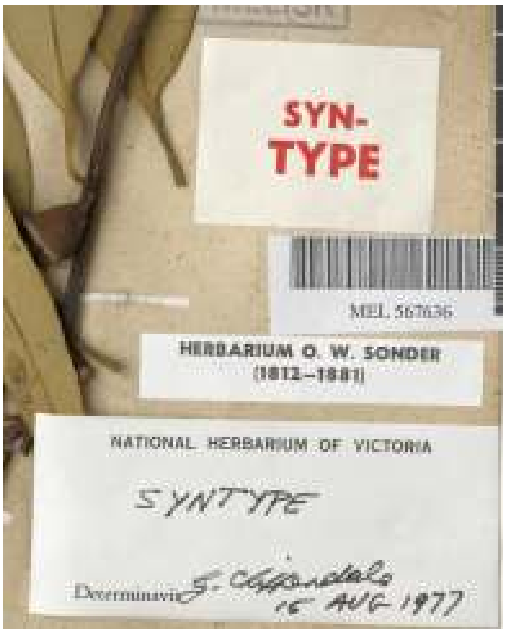
Mueller's label on Eucalyptus cosmophylla specimen.

Frank pointed out the red label "**SYN-TYPE**" which means that Mueller made a number of cuttings of *Eucalyptus cosmophylla* from different locations however, "he didn't designate which one was the "type specimen" that he specifically named the species for". Frank pointed out that "this can make it difficult in the future if botanists decide that there are variations between the three cuttings – which one is then cosmophylla"? Mueller published one of the first classifications of the eucalypts between 1879 – 1884 Eucalyptographia: A descriptive Atlas of the Eucalypts of Australia and the Adjoining Islands and he was one of the first individuals to take a scientific and conservation interest in Victoria's forests. In June 1871 Mueller wrote:
I regard the forests as an heritage given to us by nature, not for spoil or to devastate, but to be wisely used, reverently honoured and carefully maintained. I regard the forests as a gift, entrusted to any of

us only for transient care during a short space of time, to be surrendered to posterity again as an unimpaired property, with increased riches and augmented blessings, to pass as a sacred patrimony from generation to generation.

The thin label "**HERBARIUM O. W. Sonder (1812 – 1881)**" shows that this voucher at some point in its life travelled to Germany to the botanist and apothecary Otto Wilhelm Sonder where it became part of his private herbarium possibly returning to Melbourne when through Mueller's persistent efforts, the majority of Sonder's herbarium was acquired in 1883.

The label "**National Herbarium of Victoria SYNTYPE Determinavit G. Chippendale 15 AUG 1977**" shows that the CSIRO eucalyptographer George Chippendale (1921 – 2010) visited the Melbourne Herbarium in August 1977 and that he reviewed this specimen and confirmed that it was *Eucalyptus cosmophylla*. By 1977 Chippendale may have been working on his 1981 publication The Natural Distribution of Eucalyptus in Australia viewing this specimen as part of that work. Chippendale was an early advocate of the use and enjoyment of Australian native flora in home gardens.



Herbarium labels on *Eucalyptus cosmophylla*

The label on the left hand side "**Eucalyptus cosmophylla, Conf: M.I.H. Brooker Feb/March 1993**" shows the Murray Ian Hill "Ian" Brooker (1934 –) visited the Melbourne Herbarium in 1993 and reconfirmed that this specimen was E. cosmophylla. Brooker worked for the CSIRO and then joined the staff of the Australian National Herbarium in Canberra where he specialised in the eucalypts developing an interactive computer identification key to the eucalypts EUCLID between 1997 and 2006.

We reflected on how the taxonomy of the Eucalypts is now the province of molecular systematists who use plant DNA to determine relationships and therefore classifications within the genus rather than the morphology of the plants as used by Mueller. Still the voucher specimens remain extremely important as the point of reference for that particular species name, and provide us with a window into a different time and place.

When I walk down the Eucalypt Walk in the Australian Garden I think of all the stories that are embedded in these trees and it reminds me of a quote from Ashley Hay's terrific 2002 book Gum: *The Story of Eucalypts and Their Champions*:

"The scribbles make it easy to believe that there are stories hidden in the trees: if you could turn at the right moment or hold your head at the right angle, you'd catch their calligraphy resolving into words".

Planting a small eucalypt in your home garden provides habitat for biodiversity in your neighbourhood and links your garden to the ongoing story of the conservation of the Gum trees and to people like Dahl and Mueller who also treasured these trees.

ABSTRACT
Impacts of Early Thinning of a *Eucalyptus globulus* Labill. Pulplog Plantation in Western Australia on Economic Profitability and Harvester Productivity

Mauricio Acuna , Martin Strandgard , John Wiedemann and Rick Mitchell

Submitted: 13 September 2017 Revised: 30 October 2017 Accepted: 30 October 2017 Published: 1 November 2017
Forest Operations, Engineering and Management

The impact of the manipulation of plantation stocking density on individual tree size can affect final harvest costs and machine productivity. This paper investigated the impact of four early-age thinning treatments applied to a *Eucalyptus globulus* Labill. pulplog plantation in south-west Western Australia on economic profitability and harvester productivity. Eighteen sample plots were randomly laid out in the study area. The nominal 700, 500, and 400 stems per hectare (sph) plots were thinned to waste 3.2 years after establishment while the nominal 1000 sph (UTH) plots were left unthinned. The economic analysis showed that all thinning treatments resulted in a lower Land Expectation Value (LEV) and net financial loss over the full rotation at their theoretical optimal rotation age when compared with the unthinned control treatment. Tree growth and form were positively impacted by thinning. However, associated reductions in harvesting costs were less than the value losses resulting from reduced per hectare yield.

ABSTRACT
Stumps of *Eucalyptus globulus* as a Source of Antioxidant and Antimicrobial Polyphenols

Ângelo Luís , Duarte Neiva , Helena Pereira, Jorge Gominho, Fernanda Domingues and Ana Paula Duarte

Submitted: 1 September 2014 Revised: 29 September 2014 Accepted: 10 October 2014 Published: 13 October 2014
Bioactive Compounds

These past years have seen an enormous development of the area of natural antioxidants and antimicrobials. *Eucalyptus globulus* is widely cultivated in subtropical and Mediterranean regions in intensive short rotation coppice plantations. In the Portuguese context, *E. globulus* is the third species in terms of forest area. The stump is the basal part of the tree, including the near-the-ground stem portion and the woody roots that remain after stem felling. The purpose of this work was to study the phytochemical profile and to evaluate the antioxidant and antimicrobial properties of several crude stump wood and stump bark extracts of *E. globulus*, comparing it with similar extracts of *E. globulus* wood (industrial chips). The results showed the presence of high concentrations of total phenolic compounds (>200 mg GAE/g extract) and flavonoids (>10 mg QE/g extract) in *E. globulus* stump extracts. Generally the stump wood extracts stands out from the other ones, presenting the highest percentages of inhibition of linoleic acid oxidation. It was also possible to conclude that the extracts were more active against Gram-positive bacteria, presenting low MIC values. This study thus provides information supporting the economic valorization of *E. globulus* stump wood.

ABSTRACT
Seedling Growth and Physiological Responses of Sixteen Eucalypt Taxa under Controlled Water Regime

Paulo H. M. Silva , Otavio C. Campoe, Rinaldo C. de Paula and David J. Lee

Submitted*: 3 November 2015 Revised: 12 May 2016 Accepted: 16 May 2016 Published: 24 May 2016*

We assessed growth and physiological responses of *Eucalyptus* and *Corymbia* species to water limitation aiming to widen possibilities for plantations in dry climatic conditions. We selected 16 taxa: 4 *Corymbia* and 12 *Eucalyptus* species from the Subgenera *Symphyomyrtus*. Seedlings were evaluated from 100 to 170 days after sowing. Growth and physiological traits showed significant differences among taxa and between two levels of water availability. Water limitation significantly impacted biomass production and physiological characteristics, however in different levels. Leaf area and biomass production decreased 15%–48% under water limitation among taxa. *Eucalyptus moluccana*, CCV 2, and VM1 (drought tolerant clone) showed the largest decrease in leaf area. Transpiration across taxa decreased 30%–57% and photosynthesis 14%–48% under water limited condition. Taxa from cold environments were less responsive in leaf area reduction under water limitation, and taxa from *Exsertaria* section showed lower reduction in photosynthesis (*E. camaldulensis*showed the lowest reduction). Responses to water limitation are related to the environment of origin. *E. molucana*, the only *Adnataria* species from a high precipitation region (>1500 mm year^{-1}), was one of the most sensitive in reduction of biomass production, different behavior from the other *Adnataria* species, originated in regions with rainfall <750 mm year^{-1}. Water limitation increased leaf-level water use efficiency by 18% on average, 8% in *E. longirostrata*, and 28% in *E. camaldulensis*, *E. brassiana*, and *E. crebra*. Growth and physiological responses observed show the potential of different eucalypts taxa to tolerate water limited environments

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Beating the Eucalypt Blues – new ways to model air quality

Source: https://blogs.csiro.au/ecos/beating-eucalypt-blues-new-ways-model-air-quality/

By Mary O'Callaghan, April 2016

Eucalyptus are one of the highest emitters of biogenic volatile organic compounds which is what gives the Blue Mountains that blue haze. Image: Peter Asquith / Flikr

The Blue Mountains west of Sydney are not blue. But the air around them is often seen as a blue haze, especially on hot summer days.This bluish haze is caused by a chemical reaction in the atmosphere, driven by a compound called isoprene.

Isoprene is one of scores of compounds in the atmosphere that contribute to air pollution and the creation of particles that are harmful to our health. Most of these volatile organic compounds, or VOCs, are gases that are emitted from everyday substances such as paint stripper, cleaning products, furniture, even cosmetics.

“What is interesting about isoprene is that it is emitted from trees, possibly as a form of defence against pest insects”, says Dr Kathryn Emmerson, a senior research scientist at CSIRO.
“We refer to these natural emissions of VOCs as ‘biogenic’ VOCs, or BVOCs. Biogenic means they are produced by living organisms or biological processes.”

Eucalypts the natural polluters
Of all the species of trees, one of the highest emitters of BVOCs is a genus that covers not just the Blue Mountains but most of south-eastern Australia—*Eucalyptus*. Because of this, the region is considered a global hotspot for BVOCs. “Emission rates for eucalypts vary hugely, even for different plants of the same species of eucalypt”, says Kathryn. Yet, the world’s state-of-the-art model for predicting BVOC emissions from nature—MEGAN (the Model of Emissions of Gases and Aerosols from Nature)—has classified eucalypts as a high emitter across the board.

MEGAN, which is used by the US and Europe to project the concentrations of BVOCs in the atmosphere, uses meteorological data, land-use data, and emission factors based on observations.
Up to recently, the CSIRO air quality team had only a basic way of predicting BVOCs for Australia. “We’ve now incorporated MEGAN into CSIRO’s air quality model, CTM”, says Kathryn. “We use the CTM for modelling air pollution and for forecasting smoke from bushfires.” Air pollution is monitored using a mass spectrometer. Photo: CSIRO

Modelling throws light on emission rates
The team also measured the actual rate of emissions at four sites across the southeast, at different times of the year. When Kathryn compared the model projections with the observed measurements, she was surprised at how much they differed. For isoprene, the predictions were overestimated by a factor of six.
“It seems that eucalypts may not emit as much isoprene as was previously thought”, says Kathryn. “The high BVOC emission rates used in the model are based on young eucalypt trees, less than seven years old, and it may be that these young trees emit more isoprene than adult trees.” Kathryn also found that no single emissions factor suits all seasons and all conditions. “We can tweak the emission factors for eucalypts in the model, but each site needs to be treated individually.

The implications for Australia’s air quality
Australia must monitor air quality under the National Environment Protection Measures which aim to reduce our exposure to harmful smogs. “Sydney is surrounded by eucalypt forests so we need to understand these BVOCs to better control pollution”, says Kathryn. “Isoprene contributes to that chemical mix. So what we need to do next is remap emission rates for the whole southeast region.

"The region will still be a global hotspot, but better BVOC measurements for the region will make our calculations for the continent more accurate. "Isoprene is so reactive that it's a hot topic; our research will also inform the global chemistry models."

Taking to the skies to improve the model

In an exciting prospect for Australia, researchers from the US National Center for Atmospheric Research (NCAR) in Colorado, who built MEGAN, are keen to come to Australia and measure the region's emission rates from the air. A similar offer from Britain is being discussed. "All our BVOC measurements have been taken at ground level", says Kathryn. "NCAR would bring their own Hercules aircraft, which is fitted out like a flying laboratory, with particle counters and chemical analysers on board. The aircraft zig-zags across the canopy, continuously taking in air and giving us real-time measurements."

Kathryn is coordinating an international bid to the US National Science Foundation to fund the NCAR aircraft time. Several Australian universities are also interested in participating.
"We're aiming for summer 2019", she says, "Summer is peak emissions time."

ABSTRACT

Seed viability of early maturing alpine ash (*Eucalyptus delegatensis* subsp. *delegatensis*) in the Australian Alps, south-eastern Australia, and its implications for management under changing fire regimes

Michael D. Doherty, A. Malcolm Gill, Geoffrey J. Cary and Mike P. Austin+ Author Affiliations

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Eucalyptus delegatensis R.T. Baker subsp. *delegatensis* is an interval-sensitive, fire-killed eucalypt that dominates large tracts of montane forest in the Australian Alps. Although it has been widely accepted in forest management that *E. delegatens*is takes 20 years to flower and fruit after stand-replacing fire events, recent observations after high intensity fires in the Australian Alps have shown that early flowering and fruiting is occurring from what can be termed 'precocious' individuals in some areas. In some instances, early flowering and fruit set is occurring within 6 years after stand-replacing fire. One historical study in the Australian Capital Territory had noted that such seed was viable, but we found no reported experiments documenting this or detailing the degree of viability. Here we discuss the results of a germination experiment undertaken on seed collected from Namadgi National Park from early-maturing alpine ash trees. Although at the low end of known viability estimates for *E. delegatensis*, seed from these individuals was nonetheless found to be viable, with a mean of 455 (s.d. = 139) germinants per 10 g of chaff and seed mix. We discuss this result in relation to fire management in the Australian Alps and suggest further research that needs to be undertaken to better document and understand the phenomenon.

Eucalypt research finds Australian toughness key to survival

By Mark Smith, Senior Media Office, Western Sydney University, 2016

Source:
https://www.westernsydney.edu.au/newscentre/news_centre/story_archive/2016/eucalypt_research_finds_australian_toughness_key_to_survival

Eucalypt trees have been described as the ideal Australians - versatile, tough, sardonic and self-mocking. A new study has found that these distinctly Australian qualities are what gives the native trees the ability to thrive in the harsh local climates.

Published in leading environmental journal Ecology Letters, the study from Western Sydney University, CSIRO and the University of Sydney, has shown how toughness, contrariness and complexity help this remarkable tree genus cope with Australia's diverse environmental conditions.

The study of 28 species from across Australia, led by Dr Sebastian Pfautsch from the Hawkesbury Institute for the Environment, found the structure of water-conducting vessels in the trees (similar to the system of veins and arteries in people) were forced to evolve in vastly different ways in order to adapt to local climates.

"Eucalypts are known to the world for their 'toughness' in the face of drought, and generations of scientists have investigated how they came to thrive across the huge range of climates in which they grow," says Dr Pfautsch.

"What's particularly remarkable about eucalypts is how they maintain the delicate balance between need to transport water to their crowns, and eventually to the atmosphere, against the requirement to maintain hydration."

"For the first time, we have pinpointed the evolutionary journeys of the vessel architecture in various species to provide new answers as to why they are so widespread in Australia."

The study found that species adapted to the driest conditions (e.g. Mallee eucalypts) have vessel systems with very different physical properties to those adapted to cooler, wetter conditions (e.g. Alpine Ash). The differences among species serve to ensure that water transport remains continuous, and doesn't break down under stress. One of the principal differences lies in the diameter of the vessels, with narrower vessels better for coping with arid conditions, and broader vessels suited to moving larger amounts of water.

"Surprisingly, we found that all species have a mixture of vessel sizes, which helps them cope with both drought and flooding rains," says Dr Pfautsch.

"When there is plenty of water available, the larger vessels work to ensure more water can be safely transported to the crowns."

The findings cast doubt on theories derived for a wide range of tree species around the world, which suggest tree height, and not climate, is a better predictor of vessel dimensions.

"Importantly, the features of vessels and wood structure in eucalypts appear to be dictated by genetically fixed information, and not just an adaptation within species – an 'arid' species growing in a wetter environment maintains the same 'arid' vessel structure," explains Dr Pfautsch.

"This means that different Eucalyptus species have adapted over long periods of time to best cope with the environmental conditions in which they grow."

"This difference makes the trees distinctly Australian, echoing Stephen J. Pyne's description of eucalypts as 'the ideal Australians - versatile, tough, sardonic, contrary, self-mocking, with a deceptive complexity amid the appearance of massive homogeneity.'"

Species profile: *Eucalyptus cosmophylla*; Cup gum

Source: *Euclid*

Description

Tree to 10 m tall, or mallee to 5 m tall. Forming a lignotuber.
BARK smooth throughout or with a few loose basal grey or brown rough slabs; smooth bark becoming granular with age, white to cream, grey, blue-grey or yellow.

LEAVES Juvenile growth (coppice or field seedlings to 50 cm): stems square and slightly winged; juvenile leaves always petiolate, opposite until node 4 or 5, then alternate, deltoid to broadly ovate, 4–9 cm long, 4.5–9.5 cm wide, base truncate to tapering or sometimes oblique, apex emarginate, rounded or apiculate, concolorous, dull, green.
Adult leaves alternate, petiole 1.5–4 cm long; blade lanceolate to broadly lanceolate, 8–18 cm long, 1.3–5 cm wide, base tapering to petiole, or oblique (sometimes), concolorous, slightly glossy to dull, light green to grey-green, side-veins greater than 45° to midrib, moderately to densely reticulate, intramarginal vein well removed from margin, oil glands island, intersectional or obscure.
INFLORESCENCES axillary unbranched, peduncles 0.1–1.3 cm long (often very short); buds 3 per umbel, sessile or shortly pedicellate (pedicels 0–0.6 cm long). Mature buds ovoid to pyriform (1.1–2.2 cm long, 0.7–1.5 cm wide), green to yellow, scar present, operculum conical to rounded to beaked, stamens inflexed, anthers cuboid to oblong, versatile, dorsifixed, dehiscing by longitudinal slits (non-confluent), style long, stigma blunt, locules 4 or 5, the placentae each with 8–10 vertical ovule rows. Flowers white.

FRUIT sessile to shortly pedicellate (pedicels 0–0.7 cm long), cup-shaped to cylindrical, 0.9–1.8 cm long, 1–2.2 cm wide, often slightly 2-ribbed longitudinally, disc descending, valves 4 or 5, near rim level.

SEED black, 1–3 mm long, pyramidal or obliquely pyramidal with ragged, almost winged, edges, dorsal surface smooth or slightly wrinkled, not winged, hilum terminal.
<u>Cultivated seedlings (measured at ca node 10):</u> cotyledons bilobed to oblong; stems square or rounded in cross-section; leaves always petiolate, opposite for 3 to 5 nodes then alternate, ovate to deltoid or orbicular, 4.3–8.5 cm long, 4–9.5 cm wide, base truncate to tapering, margin entire or subcrenulate, apex rounded, emarginate or apiculate, dull, grey-green to green.

Notes
A small, mostly smooth-barked tree or mallee of Kangaroo Island and the Mt Lofty Range in South Australia. *E. cosmophylla* is easily recognised by the 3-budded inflorescences and the large, sessile or shortly pedicellate buds and fruits. Associated 3-budded species are *E. leucoxylon,* which differs by the slender pedicels and lack of an operculum scar, and the much taller *E. viminalis* and *E. dalrympleana,* which differ by the smaller buds and fruit and the numerous pairs of opposite, juvenile leaves (alternate after 4 or 5 nodes in *E. cosmophylla*). *E. paludicola* has pendulous buds in 3s and 7s and fruit to 1.5 cm wide.
Eucalyptus cosmophylla is one of two species in *Eucalyptus* subgenus *Symphyomyrtus* section *Incognitae* having cotyledons bilobed, leaves concolorous with intersectional or obscure oil glands, erect inflorescences with buds in 3s, buds with 2 opercula, inflexed stamens and ovules usually in 8 or 10 rows, and fruit with valves not enclosed. *E. paludicola* is closely related to *E. cosmophylla* and differs as outlined above.

Flowering Time
Flowering has been recorded in March, April, May, July, September, October and November.
It has been used for timber, fuel and grown as an ornamental. Apiarist use is for the production of honey.

Origin of Name
Eucalyptus cosmophylla: Greek *cosmos,* order, form, ornament and *phyllon,* leaf, allusion obscure.

Are Australian eucalypts to blame for California's wildfires?

Source: http://www.australiangeographic.com.au/topics/science-environment/2017/12/are-australian-eucalypts-to-blame-for-california%e2%80%99s-wildfires

By Angela Heathcote, December 12, 2017

It's been suggested that the introduction of Australian eucalyptus trees may be to blame for the rapid spread of the Southern California wildfires. But experts say the claims just don't stack up.

EXACTLY WHAT caused the Southern Californian wildfires, which have since devastated areas from Los Angeles to Ventura, has remained a mystery. The fires have managed to erupt during a time of year when the weather begins to cool, across parts of Southern California that aren't known as fire zones.

Consequently, explanations for the fires and how they're managed to spread so far and so quickly have bordered on conspiracy, and now even Australia has been chucked into the blame game.

A post titled 'The Great Australian Shitpost, 100 years in the making' was published on Reddit on the 6 December and has since garnered over 900 comments, prompting a comprehensive debunk of the tongue-in-cheek accusation by Stefan Kostarelis for Techly, a lifestyle and tech publication.

In the article, Stefan examines the author of the post's suggestion that Australian eucalypts — introduced to the area, not native — are to blame for the wildfires as the oils they secrete are highly flammable. But he ultimately concludes that the allegations are unanimously false.

Eucalypts in southern California

The author of the Reddit post argues that Australians "duped" Californians into buying Eucalypt seeds back in 1920, which they than planted across thousands of acres.

Rather, a detailed and thoroughly researched piece by Nathan Masters for KCET, argues that eucalypts were first introduced by a single farmer, William Wolfskill, back in 1865.

"William Wolfskill planted five specimens outside his house… An agricultural experimenter who made a fortune growing oranges, walnuts, and wine grapes, Wolfskill must have recognized the eucalyptus' potential to upset the commercial timber market," Nathan writes.

After selling his land, another farmer, Ellwood Cooper, renowned for his guidebook *Forest Culture and Eucalyptus Trees*, planted a 200-acre eucalyptus grove near Santa Barbara in 1872, and more widespread cultivation of the tree across south California began.

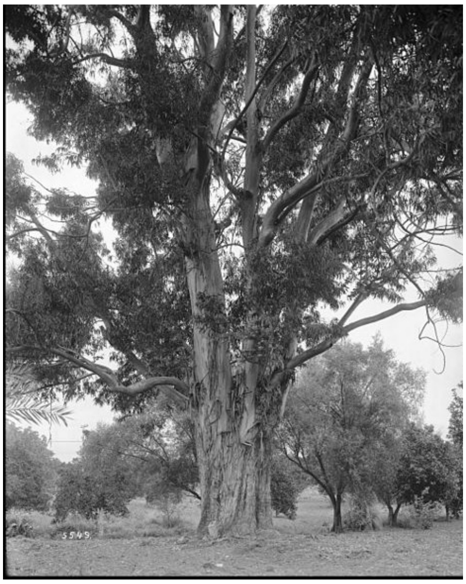
Eucalyptus trees take "100 years" to mature?

The other claim the author of the Reddit post makes is that, after duping Southern California farmers into purchasing eucalyptus seeds, Australians forgot to mention that it would take over 100 years for the tree to fully mature.

Chris Brays, a palaeoclimatologist from Monash University, told *Australian Geographic* that this is incorrect.

"The original claim that it takes 100 years to mature is complete nonsense - one of the main reasons why Eucalyptus plantations are so lucrative is because they grow so damn fast.

"Their fast growth is also adaptive in the case of fire... when a blaze scorches an area, the trees that can re-grow and capitalise quickly in the disturbed environment will be the ones that survive and flourish."



California eucalyptus tree.

Highly-flammable eucalypt oils

Chris added that while the oils secreted by the Eucalypt tree are highly flammable, he says that one particular study from 2012, published in the *International Journal of Forestry Research*, showed little difference in fire risk between pines and Eucalyptus in southern USA.

"Introducing select Eucalyptus species into the fire-prone landscape of the southern Coastal Plain raised the spectre of altered fire behaviour and greater risk of destructive wildfire, given the nature of wildfires in Australia where Eucalyptus are native.

"Although there is little empirical information on the fire behaviour in Eucalyptus plantations under the weather conditions found in the southern Coastal Plain, our modelling effort focusing on fire behaviour at the stand level suggests that little may differ from current conditions, given the flammable nature of the native pine species," the authors concluded.

Another palaeoclimatologist from Melbourne University, Patrick Baker said that the weather, coupled with flammable vegetation are the likely culprits.

"The problem here is that the weather has been shocking. I was in Ventura two weeks ago and it was 35 degrees in November. The Santa Ana winds that have kicked up have created a perfect storm of flammable vegetation.

Similarly to Chris, Peter pointed out that Southern California's native vegetation is flammable in its own right.

"The native vegetation on the hills is very flammable. Intense heat, brutal winds and a spark is all that is needed to start a fire and the whole place will go up in flames," he said.

Australia could fly on Eucalyptus

Source: https://www.timberbiz.com.au/australia-could-fly-on-eucalyptus/

Australia's economy may have ridden on the sheep's back but the colonies' first export was actually Eucalyptus oil. From a small batch of oil distilled from Sydney peppermint gum sent to England by First Fleet Surgeon-General John White, an industry grew around the use of the oil for medicinal and industrial purposes. Source: The Conversation

As demand grew around the world, Australia dominated the global supply. But as the 20th century progressed, cheaper production from plantations in Spain, Portugal, South Africa and China drove Australia's market share down to less than 5%.

Today the global market for Eucalyptus oil sits at around 7000 tonnes each year, with a slowly growing demand and price.

In fact, Australia is now a net importer of its own iconic oil! But a range of cutting-edge new uses for plant-based oils appear set to give this old dog some new tricks, potentially jolting the local eucalyptus oil industry out of its sleepy niche and into the high-tech limelight.

Eucalyptus oils are a cocktail of aromatic compounds called terpenes. The oil that is sold in pharmacies and supermarkets is dominated by one compound called eucalyptol that instantly gives it a recognisable medicinal scent.

This oil is sourced from about a dozen species. There are many other types of oils from Eucalyptus.

Oil from the lemon-scented gum, for example, is full of citronellal, which is used in perfumes and insect repellents.

What makes a specific oil valuable are the commercial uses for the major terpenes found in that oil.
Powering a modern jet aircraft with anything other than fossil fuels is a big ask.
Renewable ethanol and biodiesel might do fine in the family SUV, but they just don't possess a high enough energy density to cut it in the aviation industry.

Certain terpenes commonly found in oils from eucalypts, such as pinene and limonene, can be refined through a catalytic process, resulting in a fuel with energy densities in the same league as JP-10 tactical jet fuel.

Turpentine from pine trees is another potential source of these terpenes, but pines grow more slowly than eucalypts.

As a pure fuel, or as an additive to standard aviation fuels, the potential exists to carve out a renewable slice of the enormous aviation fuel market, if the volume of terpene production can be increased to economically competitive levels.

Current plantations produce up to 200kg of oil per hectare per year, but by selecting the best genetic stock it is estimated that yields could be more than 500kg per hectare.
The 2010 Nobel Prize in Physics was awarded for the discovery of the physical properties of graphene, a two-dimensional carbon grid or film, less than one-millionth of a millimetre thick yet more than 100 times stronger than steel.

In fact, a square metre of graphene can support the weight of a house cat, but weighs less than one of its whiskers.

Production value in 2012 was US$9 million and growing fast, and new ways of producing graphene are keenly sought.

Terpinene-4-ol, which is found in Eucalyptus and its close relative tea tree, is an ideal starting material for the direct production of high-quality graphene.

This method is scalable and sustainable, potentially providing the solution to the growing demand for graphene and opening up further innovative uses for Eucalyptus oil.

Worldwide, more eucalypts are grown for the production of pulp, paper and timber than any other type of tree. However, all of that global production comes from just over a dozen of the almost 800 Eucalyptus species that occur naturally in Australia, and mostly from a limited ancestry.

This means the existing plantations lack genetic diversity and they also lack diversity and variability of oils. This is where Australia's advantage lies.

We have the choice of 800 species growing in every imaginable ecological niche and possessing vast genetic diversity.

For example, within a single species the amount of oil found in leaves can vary 30-fold among wild individuals, which can contain as many as six different major oil variants.
Australia has a veritable smorgasbord of variation from which to select plants with high yields of the right oil for new commercial purposes. Growing eucalypts for oil can provide benefits beyond the commercial value of the terpenes.

Several Eucalyptus "mallee" species, which happen to be prolific oil producers, are purposely planted in wide rows on agricultural land to combat dryland salinity and prevent soil erosion.

Mallees are known for their bushy form, which is best described as a "ball of leaves", and can be re-harvested for oil every 1-3 years. This puts them in the rare class of being renewable oil crops with added ecological benefits.

Ramping up oil production would still require large, dedicated plantations.

A frequent criticism of biofuel crops is that land suitable for food production is diverted to fuel production, in turn pushing up food prices. But many eucalypts can grow well on marginal land that is not used for other agricultural purposes, skirting this issue altogether.

With the right genetics from the right species grown in the right places, the humble Eucalyptus oil may be on the verge of an ecologically sustainable renaissance.

ABSTRACT

Insect herbivory on snow gum (*Eucalyptus pauciflora*, Myrtaceae) saplings near the alpine treeline: the influence of local- and landscape-scale processes

Citra D. Dashiell , Shannon LeBel , Peter T. Green , Susanna E. Venn and John W. Morgan + Author Affiliations

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The distribution and abundance of plant species in high mountain ecosystems are thought to depend largely on abiotic factors that play out at both landscape scales (e.g. steep environmental gradients affected by increasing elevation) and local scales (e.g. changes in topography, aspect and canopy cover). However, relatively little attention has been paid to biotic interactions, and how these might also change with landscape-wide and local factors. Ecological interactions between plants and insect herbivores are likely to alter species performance and affect local abundance, but their role in the Australian Alps remains largely unexplored. Here, we examine the prediction that the amount of herbivory on saplings of the dominant high elevation tree, snow gum *Eucalyptus pauciflora* Sieb. ex Spreng. (Myrtaceae), are lower at higher elevation

because of increasing environmental stress. Using a reciprocal transplant experiment, we tested the prediction that origin of seed (low, mid, high elevation) has less effect on insect herbivory than environmentally-driven changes in plant morphology (height, leaf thickness, specific leaf area). Across all mountains studied, herbivory was best explained by a combination of plant height, canopy openness, leaf thickness and elevation, but not seed origin. This study highlights the individuality of each mountain environment, at landscape and local scales, as well as the complexity of relationships between environmental change, plants and insects. Given the factors that best explain herbivory across mountains, herbivory may decrease with decreasing productivity associated with increasing elevation, a trend in broad agreement with hypotheses associating leaf area loss to the availability of resources and plant vigour.

ABSTRACT

Genetic diversity and the insular population structure of the rare granite rock species, *Eucalyptus caesia* Benth.

GF Moran and SD Hopper

Australian Journal of Botany 31(2) 161 - 172, Published: 1983

There are 15 populations of *E. caesia* Benth. on granite rocks in south-westem Australia which include a total of about 2120 plants. The level of genetic variation at 18 allozyme loci in 13 populations was estimated. Seven loci were monomorphic for all plants assayed. At a majority of the 11 polymorphic loci the level of polymorphism was very low in most populations. Within populations the mean number of alleles per locus was 1.31 and the genetic diversity 6.8%. However, populations differed markedly in allelic frequencies at a number of loci. The genetic diversity within populations was remarkably low for a tree species but the level of population differentiation was the highest reported for any tree species. The data suggest that genetic drift may in part have been responsible for the low overall genetic diversity and the extensive population differentiation. The optimal strategies for conservation of the genetic resources of this valuable ornamental are considered in the light of the results of this study.

E. caesia 'Silver Princess'

Source: http://www.homelife.com.au/gardening/plant-guides/native-silver-princess

Articles, requests and questions are needed
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