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Eucalyptus Study Group Newsletter

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Contents

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

Greetings members, the group has been within a temporary recess for the past eighteen months and this has initiated with the sudden and unexpected passing of Stephen Harries in October 2018. Steve has been a long term member of the ESG and has acted as the membership secretary for several years, providing the backbone of the group by both collating membership, finances and distributing the newsletter. Steve has always been a pleasure to deal with, relaxed, with little to faze him, and always supportive. His passing has been a blow to many friends and family, and has in particular affected my momentum with continuing in this role.

Steve was a man of integrity and honesty. He was kind and generous and one of natures true gentlemen. He is a reminder, that the legacy outlives the life, and is embodied in the eucalyptus genera….life itself.

Sheryl Backhouse has most admirably offered her services in sustaining the group, and taken on the role of the membership secretary , although as a temporary position. Sheryl also manages other groups, and I applaud her with the additional undertaking. Although this position is considered vacant and will require to be filled in the near future for the continuation of the group. In addition, and after ten years as the study group leader, I will be providing my resignation in the near future. I will retain the role as the study group leader throughout the remaining year, although will be providing notice as of this newsletter. As well as the membership secretary, the group leader will also require to be filled within the following 12-18 months.

Tree grafting a way to bring koala habitat to urban areas

Source: ECOS, Published: 28 July 2014

Tree species eaten by koalas are generally unpopular with both urban landowners and councils due to falling limbs and larger sizes. Grafting these species to smaller trees may boost koala forage and habitat in urban areas.

After a series of trials, researchers from the University of the Sunshine Coast have found at least one grafted combination that could provide a valuable habitat tree for koalas and other fauna in urban areas, according to a paper published in the Australian Journal of Botany.

'We aimed to develop shorter koala trees for subtropical urban areas by using related short species as dwarfing rootstocks for tall species that are eaten by koalas' says the paper's lead author Stephen Trueman. The koala is classed as vulnerable in Queensland, NSW and the ACT where their habitat is increasingly fragmented through urban development. Other threats to koala populations include disease, inbreeding, dog attacks, fire, drought and being hit by a car.

Koalas in urban and peri-urban areas are often forced out of habitat by development. Local councils are beginning to see an urgent need to revegetate urban areas with koala food and habitat trees. ‘The ideal koala food and habitat trees for planting in gardens and residential streets would be small, safe, and palatable to koalas’ says Dr Trueman.

After testing 14 graft combinations, they found one that was most successful. When grey box (*Eucalyptus moluccana*) was grafted to blue mallee (*Eucalyptus behriana*) the height of the tree was reduced from around 10 metres to 4 metres. There was a survival rate of 40% in the trial that may be improved in an urban setting.

Even though this research is now over and these trees are not yet available, the researchers hope that in the future grafted trees could be valuable habitat trees for koalas and other fauna in urban areas.

ABSTRACT; Effect of temperature and light on germination of 10 species of Eucalyptus from north-western NSW

Lorena Ruiz-Talonia A C , David Carr A , Rhiannon Smith A , R. D. B. Whalley B and Nick Reid A
Australian Journal of Botany 66(8) 657-666 https://doi.org/10.1071/BT18115

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The effects of temperature and light were examined on the germination of 14 seedlots of 10 Eucalyptus species, which are important for revegetation of native communities in north-western New South Wales. The species tested were E*. albens, E. blakelyi, E. chloroclada, E. dealbata, E. camaldulensis, E. melanophloia, E. melliodora, E. pilligaensis, E. populnea and E. sideroxylon*. Species were subjected to three alternating day/night temperatures (15/5, 25/15 and 35/25°C), representing winter, spring/autumn and summer conditions, respectively, and two light treatments (light/dark or dark), in growth cabinets. Limited quantities of seed of most seedlots prevented full factorial combinations of most treatments. Overall germination was high but varied significantly between species and seedlots within species. Differences were small, but light combined with winter or spring/autumn temperatures resulted in higher average germination (96%) than darkness and summer temperatures (93%). Seedlots of *E. chloroclada, E. blakelyi, E. camaldulensis, E. sideroxylon, E. melliodoraand E. melanophloia* germinated consistently well under all treatment conditions, whereas germination in seedlots of *E. albens, E. dealbata, E. melliodora, E. pilligaensis and E. populnea* varied with treatments. Germination of small seeds was higher in the presence of light whereas larger seeds germinated better in continuous darkness. The time to first germination was three times faster under summer and spring/autumn temperatures than winter temperatures. In conclusion, temperature and light can significantly impact germination percentage and rate, depending on the species and provenances, and therefore should be considered in planning restoration projects in both nursery and field.

Smart city planning can preserve old trees and the wildlife that needs them

Source: Philip Gibbons, July 2, 2018,

Australia's landscapes are dotted with mature eucalypts that were standing well before Captain Cook sailed into Botany Bay. These old trees were once revered as an icon of the unique Australian landscape, but they're rapidly becoming collateral damage from population growth. Mature eucalypts are routinely removed to make way for new suburbs.

Good planning can ensure many more mature eucalypts are retained in urban developments. Philip Gibbons

This has a considerable impact on our native fauna. Unless society is prepared to recognise the value of our pre-European eucalypts, urban growth will continue to irrevocably change our unique Australian landscape and the wildlife it supports.

Why are old eucalypts worth saving?

In urban landscapes, many consider large and old eucalypts a dangerous nuisance that drop limbs, crack footpaths and occupy space that could be used for housing. But when we remove these trees they are effectively lost forever. It takes at least 100-200 years before a eucalypt reaches ecological maturity.

Birds use old eucalypts as places to perch or nest. Philip Gibbons

As trees mature, their branches become large and begin to grow horizontally rather than vertically, which is more attractive to many birds as perches and platforms where they can construct a nest.

Wildlife also use cavities inside ageing eucalypts. These are formed as the heartwood – the dead wood in the centre – decays. When a limb breaks it exposes cavities where the heartwood once occurred.

This is such a ubiquitous process in our forests that around 300 of Australia's vertebrate species, such as possums, owls, ducks, parrots and bats, have evolved to use these cavities as exclusive places to roost or nest. Mature trees also support high concentrations of food for animals that feed on nectar, such as honeyeaters, or seed, such as parrots.

One study found that the number of native birds in an urban park or open space declines by half with the loss of every five mature eucalypts.

How can we keep old trees?

Decaying heartwood in older eucalypts leads to some large branches falling. This is when most eucalypts are removed from urban areas. So we remove trees at the exact point in time when they become more attractive to wildlife.

Plantings around the base of a mature eucalypt discourage pedestrian traffic or parked cars. Philip Gibbons

A well-trained arborist knows that old — or even dead — eucalypts don't need to be removed to make them safe. A tree is only dangerous if it has what arborists call a target. Unless there is a path, road or structure under a tree, then the probability of something or someone being struck by a falling branch is often below the threshold of acceptable risk.

Progressive arborists first focus on eliminating targets. For example, they might plant shrubs around the base of dead or rapidly ageing trees to minimise pedestrian traffic, rather than eliminating trees. Where targets can't be managed, trimming trees can remove branches that have a high risk of falling. Trees can also be structurally supported (braced) to remain stable. Such trees remain suitable as habitat for many native species.

Developers can plan around old trees. from shutterstock.com

How to design around trees

The removal of mature eucalypts is, in part, due to urban developers not considering these trees early in the planning process.

I have worked with one developer on the outskirts of Canberra to identify important trees. The developer then planned around, rather than in spite of, these trees.

The outcome has been around 80% of mature trees have been retained. This is much greater than the proportion of mature trees retained in other new urban developments in Canberra

Disclosure statement

Philip Gibbons receives funding from the Australian Research Council, Government of the Australian Capital Territory, New South Wales Government and Riverview Projects Pty Ltd.

Eucalypt genome shows jet fuel potential

Source: Christopher Doyle, 12 June 2014. ABC

The genetic blueprint of an iconic Australian tree opens the way for better production of wood, medicines and possibly even eucalypt-based jet fuels.

The genome of Eucalyptus grandis (flooded gum) is published today in the journal Nature.
Native to the coastal regions of New South Wales and Queensland, flooded gum has become the species of choice for timber plantations across the world due to its hardy nature, fast growth rate and excellent quality of wood.

And now, armed with its genetic sequence, Professor Alexander Myburg from the University of Pretoria in South Africa, says there is tremendous potential to further improve the commercial value of this important species.

"Eucalypts are by far the most widely-grown fibre crop in the world and so there is big interest in understanding why they grow so fast and why they produce such large amounts of wood," says Myburg, who led the study.

"In one sweep we now have access to the full genetic blueprint of the tree, so we can see under what circumstances which particular genes are turned on or off."

By knowing which genes are important for determining key characteristics, Myburg says there is potential for breeding trees that grow faster, use water more efficiently and which will be better able to cope with climate change.

The process of selectively breeding the eucalypts will also be accelerated as there is no longer the need to wait decades for them to mature to see what traits they possess.

"If you can already predict a tree's qualities with good reliability at the seedling stage, then you can grow only the ones that are predicted to have very good properties," Myburg says.

The new study, which also provided insight into the evolutionary history of eucalypts, took five years of research involving 80 scientists from 18 countries.
Terpenes and jet fuel.

Dr Carston Küllheim from the Australian National University, who was also involved in the study, says the research provides insight into eucalypt production of useful chemicals known as terpenes.
The eucalypt genome had the largest number of genes for producing terpenes of any plant species that has been genetically sequenced so far.

Terpenes are hydrocarbons that act as chemical defences against pests, and that provide aromatic oils used in medicinal and pharmaceutical applications.

They also increase the flammability of eucalyptus leaves, adding to their susceptibility to fire.
Some derivatives of terpenes may be converted into advanced biofuels, which Küllheim says could provide an alternative to petroleum-based fuels in the future.

The terpene derivatives have the same number of carbon in the backbone like diesel fuel, adds Myburg.

"This means that in future we could use specially selected eucalyptus genes in bacteria and yeasts, turning them into bio-factories to manufacture advanced biofuels on a large scale," he says.
"In future, jumbo jets may take off powered by renewable, eucalyptus-based fuel."

Eucalyptus Hybrids; *E. melliodora* x *E. camaldulensis*

By Angie Angel (bangel@tpg.com.au)

A few years ago I produced a cross between a young River Red Gum tree growing on our place and some large mature Yellow Box trees.

This happened after taking seed from the vigorous young Red Gum and finding that the resultant seedlings were about 50/50 pure River Red Gum and some unknown box-like seedling

E.Camaldulensis

I took the seedlings into CSIRO (Commonwealth Scientific Industrial Research Organisation) where a eucalypt expert, Mr Ian Bruckner, confirmed that they were hybrids, (River Red Gums hybridise readily and there is no reason why they would not cross with *E.melliodora* – Yellow Box). Mr Bruckner said that though he was 99% sure of its hybrid nature, he would nevertheless like to further confirm after seeing the flowers of the suspected hybrids.

I am still waiting for them to flower, but their growth and interesting behaviour seems to further confirm their *E.melliodora* X *E.camaldulensis* hybrid nature. Before I discuss their present growth habits, I will digress and discuss why the two trees are of particular interest.

Ecological considerations

When I saw representatives of CSIRO back in 1994, they told me that their work in hybridising eucalypts mostly revolved around the softer pulpwood species. They were concentrating on crossing species so that pulpwood plantation farmers could grow pulpwood trees in colder areas. Admirable as this might be, the slower growing Ironbarks and Boxwood trees are not regenerating in their native habitat, and their timber, which is the hardest and heaviest in the world, and which cannot be excelled for its durability and myriad uses, from heavy construction to railway sleepers and fence posts, is becoming more scarce, and is being replaced by shoddier products.(Ironbark is so heavy, the early settlers found that they could not build boats out of it, as it would sink.)

E.Melliodora - about 30 metres tall

The CSIRO magazine ECOS said in 1994 about natural Boxwood woodlands in Australia:
Before European settlement, grassy box woodlands covered millions of hectares between Southern Queensland and Northern Victoria. They featured eucalypt species such as Yellow Box, Grey Box and White Box with an understorey of kangaroo grass, wallaby grass, and snowgrass and wildflowers such as yam daisies, donkey orchids and chocolate lilies.

Scattered trees remain, but native understorey has been eliminated from most sites. Prober and her colleagues are studying the ecology and genetics of remnant grassy White Box woodlands to develop a strategy for conserving threatened woodland ecosystems. They estimate that less than 50 hectares of the original woodlands remain intact.

The Box species are disappearing and regeneration is not happening. Originally growing in the more fertile valleys and woodlands rather than ridges, they were in the way of what looked like good grazing land, and were zealously cleared.

Regrowth is subject to insect attack which kills many trees, and farmers, who prize Boxwood for its uses as fenceposts and as a fiercely hot and slow burning fuel, lose patience when it comes to waiting for these trees to regrow. The average growth rate of Yellow Box is about one inch a year. I have some naturally regenerating Yellow Box trees on my place which in ten years don't appear to have grown at all, and some have even been retarded in their growth by the native pests that plague them. At their young stages of growth many regenerating Box trees are lost to pests.

They become too big and dangerous to be cultivated as park or backyard trees. Like most eucalypts, they eventually drop branches, and these outlandishly heavy branches are often the size of a medium tree. They are definitely farm trees.

In Australia, you still pay extra for firewood that can be guaranteed to be Yellow Box, and its very desirability as a fuel has helped in the tree's demise.

E. camaldulensis, (River Red Gum) on the other hand is still the most widespread eucalypt species in Australia and exists all over Australia, not just in that eastern belt that characterises the box woodlands. Being more straight grained than *E.melliodora* it has been harvested widely for construction purposes, and originally contributed heavily to Australia's railway sleepers in the construction of railways. Along the Murray river where it was most widespread, astronomical amounts of mature trees have disappeared, being cleared in the wake of the food and irrigation belt, and now more are many dying because of altered flood plains and salinity. Unlike Yellow Box which is a tree of the high dry fertile plains, River Red Gum is a tree of rivers and flood plains. Its heavy red timber is ideally suited to heavy construction.

Both trees are heavy honey producers, and Yellow Box honey is one of the finest honeys available anywhere.

Growth habits

I have already mentioned the slow growth rate which has contributed to Yellow Box's inability to compete in regeneration – particularly when this is combined with the introduction of choking exotic plant species and the tendency to be prone to devastating insect attacks which set it back even further when they don't kill it. Once upon a time the insects would have killed off a certain quota, leaving others to continue to grow. Now there are fewer yellow box trees regenerating and the pests have less to choose from. More are prone to various degrees of blight.

River Red Gum on the other hand is a relatively robust tree and a relatively fast grower. It is more sensitive to fire than Yellow Box (it has no lignotuber and does not regenerate easily after a fierce bushfire) but all in all, is a more disease resistant tree. It is also more frost prone than the frost resistant box trees, but again, it shows great variation within the species, and River Red Gums from some areas (such as Victoria for instance) are more cold resistant than River Red Gums growing elsewhere (such as the Northern Territory).

I was experimenting growing River Red Gum in an extremely cold area (near Canberra, which is not it's native habitat) and these particular trees which came from Victoria proved remarkably successful. One grew 7 metres tall and 5 metres wide (it had a remarkably leafy and wide crown) in 10 years. For all its setbacks suffered in an inordinately cold climate, it grew remarkably quickly. It was from this tree I took seed and discovered it had hybridised with the locally native (but dying) Yellow Box trees.

Why hybridise hardwoods?

It has been the Australian hardwoods that were most taken for granted and seen as an infinite resource, which now is no more. They were burnt and still are, widely, with their slow, hot burning timber being prized for fuel. The timber, being hard to work, was substituted for Radiata Pine in the building industry, but nothing can replace hardwood's durability and termite resistance. Softer timber eucalypts are sought after for the pulpwood and paper industry, and heavy timber railway sleepers have been replaced by concrete ones. We still however, chose to build our house out of Australian hardwoods (even recycled bridge timbers) and though the construction was slower and required heavy power tools, the result is one that is more durable and pleasing. When dressed and polished, the dense grained hardwoods are excellent for funiture making, exposed building timbers and other purposes. I would like to believe that the heavy hardwoods are there for future generations. In inadvertently crossing Yellow Box and River Red Gum , I hopefully also have some good honey producing hybrids growing. Time will tell.

Hybrid (left) grows comparably to young River Red Gum (right). Both were planted in 1994 as seedlings from the same parent River Red Gum tree and are growing well under adverse conditions. The hybrid, unlike its River Red Gum parent, has a lignotuber.

Results so far

The hybrids I have growing on our land are growing in the most adverse conditions possible, suffering about 5 months of frosts a year, and bitterly cold winds. I am sure they would be growing faster in more optimum conditions. Nine were planted in 1994 and all nine are alive and thriving. I intend to generate some more. So far, they have displayed what is called hybrid vigour. They look like a disease resistant version of a young Yellow Box (see photo below) but grow at a rate comparable to a River Red Gum. Notice the photo is of a young hybrid growing next to a control River Red Gum and they are of comparable growth rates, about five feet in six years, which I admit is not fast, but which I'm sure would be increased in a more hospitable climate. Both require relatively fertile, or at least clayey soils. I expect that like its parents, the hybrid will not be a backyard tree, as both trees are large, growing to at least thirty metres eventually.

I am particularly interested in keeping the Yellow Box genes alive and would hate to see the demise of this beautiful and useful tree.

ABSTRACT

A dated molecular perspective of eucalypt taxonomy, evolution and diversification

Andrew H. Thornhill A B C H , Michael D. Crisp D , Carsten Külheim D E , Kristy E. Lam A , Leigh A. Nelson F , David K. Yeates F and Joseph T. Miller A G

Australian Systematic Botany 32(1) 29-48 https://doi.org/10.1071/SB18015

Submitted: 25 March 2018 Accepted: 14 February 2019 Published: 9 April 2019

The eucalypts, which include *Eucalyptus, Angophora* and *Corymbia*, are native to Australia and Malesia and include over 800 named species in a mixture of diverse and depauperate lineages. We assessed the fit of the eucalypt taxonomic classification to a phylogeny of 711 species scored for DNA sequences of plastid matK and psbA–trnH, as well as nuclear internal transcribed spacer and external transcribed spacer. Two broadly similar topologies emerge from both maximum likelihood and Bayesian analyses, showing Angophora nested within Corymbia, or Angophora sister to Corymbia. The position of certain species-poor groups on long branches fluctuated relative to the three major Eucalyptus subgenera, and positions of several closely related species within those subgenera were unstable and lacked statistical support. Most sections and series of Eucalyptus were not recovered as monophyletic. We calibrated these phylogenies against time, using penalised likelihood and constraints obtained from fossil ages. On the basis of these trees, most major eucalypt subgenera arose in the Late Eocene and Early Oligocene. All Eucalyptus clades with taxa occurring in south-eastern Australia have crown ages <20 million years. Several eucalypt clades display a strong present-day geographic disjunction, although these clades did not have strong phylogenetic statistical support. In particular, the estimated age of the separation between the eudesmids (Eucalyptus subgenus Eudesmia) and monocalypts (Eucalyptus subgenus Eucalyptus) was consistent with extensive inland water bodies in the Eocene. Bayesian analysis of macroevolutionary mixture rates of net species diversification accelerated in five sections of Eucalyptus subgenus Symphyomyrtus, all

beginning 2–3 million years ago and associated with semi-arid habitats dominated by mallee and mallet growth forms, and with open woodlands and forests in eastern Australia. This is the first time that a calibrated molecular study has shown support for the rapid diversification of eucalypts in the recent past, most likely driven by changing climate and diverse soil geochemical conditions.

Gum tree parents determine heat stress survival in seedlings

Source: Andrew Masterson
https://cosmosmagazine.com/biology/gum-tree-parents-determine-heat-stress-survival-in-seedlings?fbclid=IwAR1C6IAEHEImwlbxaaOS_OQk3anKdTxssw2P0m_oHS5BZZlPq5ep8AIzg9A

Protein research reveals that coping with high temperatures is a function of location and history

Adult trees confer protection from extreme heat to their offspring by passing on certain proteins, researchers have revealed.

Scientists led by Rachael Gallagher from Australia's Macquarie University set out to test how eucalypt seedlings cope with heatwaves – weather conditions that are quite common in many parts of the world, but which are also tipped to increase in frequency and severity as climate change bites.

To make their findings, the scientists set up laboratory-based colonies of seedlings from a type of eucalypt known as Flooded Gum (*Eucalyptus grandis*).

The species is widespread and commercially valuable. Gallagher and colleagues selected seedlings sourced from across its 2000-kilometre range, in which annual temperatures range from mild to extremely hot.

In the lab, all the specimens were subjected to a realistic simulated heatwave: a four day cycle in which daytime temperatures peaked at 42 degrees Celsius and never dropped below 24 at night.
The trees that had been grown from seeds gathered from areas in which average temperatures were high, and scorching periods common, coped with the heatwave much better than those that orginated in cooler regions.

The scientists discovered that the trees from hotter areas carried within their cells a greater number of protective proteins, which functioned rather like chaperones, transporting other proteins to optimal locations within the cell.

This allowed the plants to continue to function well, despite heat stress.

The presence of the protective proteins occurs at population level, with levels increasing in line with the temperature conditions historically experienced by adult trees.

"This is a significant new finding," says Gallagher, "we have shown that trees have a 'molecular memory' for extreme heat."

The result is of immediate practical use for ecologists, land managers and forestry planners. Trees, being slow-growing organisms, can take decades to adapt to changed climatic conditions.

Establishing eucalypt colonies – and potentially colonies of many other species – using seedlings sourced from areas where the trees do not show protein adaptation is likely a recipe for expensive failure.

“By using this approach we can work out which populations might provide the best seed for restoring ecosystems and climate-proofing forestry as temperatures become more extreme,” explains Gallagher.

The research is published in the journal *Functional Ecology*.

Eucalypt reveals smelly secret

Source: Dani Cooper, 5 March 2013, ABC

Biologists have uncovered a yellowbox eucalyptus tree that is able to change the smell of its leaves from one side of the tree to the other to protect itself against predation.

The finding, published in the online journal BMC Plant Biology, answers a 20-year-old mystery surrounding a eucalyptus tree in a sheep paddock at Yeoval, New South Wales.

The tree at the centre of the study was almost totally defoliated by insects in 1990, but one branch was left completely untouched.

Lead author Amanda Padovan, a doctoral student at the Australian National University's Research School of Biology, says their study shows the yellowbox Eucalyptus melliodora is able to control which leaves are attacked by predators by alterations in its genes.

Padovan says the tree, which is estimated to be 75 years old, has developed this ability known as "genetic mosaicism" as a survival mechanism.

"If an insect outbreak occurs then a part of the plant won't be eaten and therefore it will still be able to grow and reproduce," she says.

'Cocktail of oils'

The research team collected leaves from both sides of the tree and through gene sequencing found there were 10 genes that contained differences between the leaves from each side.

Padovan says one of the main defences the eucalyptus uses against predation is its distinctive smell, which is the result of a "cocktail of terpene oils", including monoterpenes and sesquiterpenes, and formylated phloroglucinol compounds or FPCs that make animals nauseous.

The gene sequencing revealed leaves that were predation-resistant had five fewer monoterpenes and nine fewer sesquiterpenes than the leaves that were "tastier".

However the concentration of FPCs and the remaining monoterpenes was far higher.

As a result, says Padovan, the leaves on the part of the tree that was not eaten had a strong eucalyptus smell whereas the leaves that were attractive to the insects had a stronger florally smell.

Padovan says it appears the impact on vertebrates such as koalas is similar as feeding experiments in the laboratory show koalas reject the same leaves as the insects.

She says although they have searched the area nearby they have only found one yellowbox tree like this, however she suspects the trait "is more common than we know".

"Trees can't get up and walk away from unfavourable conditions and so we believe this genetic mosaicism is a way for trees to survive changing conditions throughout their life," she says.

"We believe all trees have the ability in that they can acquire mutations in their stem cells, however we believe the mutation must be favourable - in this case the mutation led to resistance against feeding ¬- to allow an entire branch to develop."

Padovan is now using gene sequencing on an ironbark eucalyptus Eucalyptus sideroxylon to see if it has similar mosaic properties.

ABSTRACT
Intraspecific variation in drought susceptibility in Eucalyptus globulus is linked to differences in leaf vulnerability

Christopher J. Lucani A , Timothy J. Brodribb A C , Greg Jordan A and Patrick J. Mitchell B

Functional Plant Biology 46(3) 286-293 https://doi.org/10.1071/FP18077

Submitted: 28 March 2018 Accepted: 19 October 2018 Published: 23 November 2018

Understanding intraspecific variation in the vulnerability of the xylem to hydraulic failure during drought is critical in predicting the response of forest tree species to climate change. However, few studies have assessed intraspecific variation in this trait, and a likely limitation is the large number of measurements required to generate the standard ‘vulnerability curve’ used to assess hydraulic failure. Here we explore an alternative approach that requires fewer measurements, and assess within species variation in leaf xylem vulnerability in *Eucalyptus globulus* Labill., an ecologically and economically important species with known genetic variation in drought tolerance. Using this approach we demonstrate significant phenotypic differences and evidence of plasticity among two provenances with contrasting drought tolerance.

ABSTRACT

Morphological, phytochemical and molecular analyses define species limits in Eucalyptus magnificata (Myrtaceae) and lead to the discovery of a new rare species

Timothy L. Collins A B , Rose L. Andrew A and Jeremy J. Bruhl A

Australian Systematic Botany 32(1) 12-28 https://doi.org/10.1071/SB18037

Submitted: 5 June 2018 Accepted: 24 November 2018 Published: 25 February 2019

Eucalyptus magnificata L.A.S.Johnson & K.D.Hill is an endangered species endemic to the New England Tablelands Bioregion of eastern Australia, with taxonomic conflict regarding its recognition. Analyses of morphology, phytochemistry and genomic DNA were used to test species limits of E*. magnificata*. Morphometric and phytochemical phenetic analyses found distinct differences among *E. magnificata, E. baueriana* and a putative entity recognised during field collection, i.e. E. sp. Dalveen. Another putative entity, E. sp. Oxley, was morphologically and phytochemically intermediate between *E. magnificata and E. conica.* Phenetic analysis of single-nucleotide polymorphism (SNP) data supported the results from morphological and phytochemical analyses. The original circumscription of *E. magnificata*, as distinct from *E. baueriana*, was strongly corroborated. *Eucalyptus magnificata* was found to be restricted in distribution to the Macleay Gorges area south-east of Armidale. Multiple lines of evidence provided strong support for the recognition of E. sp. Dalveen as a separately evolving entity at a species level, here described as *Eucalyptus dalveenica* T.L.Collins, R.L.Andrew & J.J.Bruhl. A full description of the new species, a table distinguishing *E. dalveenica* from closely related taxa, and an identification key are provided. Distribution, habitat and conservation status are discussed..

ABSTRACT

Depicting how Eucalyptus globulus survives drought: involvement of redox and DNA methylation events

Barbara Correia A, Luis Valledor B, Robert D. Hancock C, Cláudia Jesus A, Joana Amaral A, Mónica Meijón B and Glória Pinto A D

Functional Plant Biology 43(9) 838-850 http://dx.doi.org/10.1071/FP16064

Submitted: 17 February 2016 Accepted: 27 April 2016 Published: 6 June 2016

Eucalyptus globulus Labill. is widely cultivated and used by industry but its productivity is currently restricted by drought events, so research focussing on supporting programs to breed adapted germplasm is needed. In the present work we monitored severity of acute drought stress (7 and 11 days after water withholding) and relief (2 h and 3 days after rewatering) by quantifying several biochemical markers of oxidative stress and DNA methylation patterns in leaves. Water withholding imposed a mild oxidative stress as estimated by redox shifts in the major antioxidant pools and increased lipid peroxidation. At the DNA level, global 5-methylcytosine distribution increased over the dehydration period especially in vascular tissue as estimated by immunolocalisation. Using methylation-sensitive RAPD analysis, which discriminates methylation changes occurring in specific DNA sequences, we found a high number of specific demethylation events also taking place. Immunolocalisation indicated a rapid reduction in global DNA

methylation 2 h after rehydration; however, a large number of *de novo* methylation events were still detected by methylation-sensitive RAPD. These events were associated with decreased lipid peroxidation and high cellular GSH pools relative to unstressed plants. Our results indicate the parallel induction of redox and complex DNA methylation changes occurring during stress imposition and relief.

Seed Germination Data Sheet

<u>Source:</u> Greening Australia Victoria, August 1996 Copies from PO Box 525 Heidelberg, VIC 3084.

THE EUCALYPTS

Identification

Key features used in eucalypt identification include the size, shape and colour of the juvenile leaves (which are not always present) as well as the texture of the bark from the trunk to the outer branches. Samples of fruit, buds and adult leaves are also very helpful.

Difficulties in identification can arise when hybrids are encountered (eg *Eucalyptus viminalis* and *E. ovata* hybridise with various species). Hybrids can also occur between indigenous and non-indigenous eucalypts resulting in genetic contamination of remnant populations (eg *E. pryoriana x E. botryoides* in the Melbourne suburbs).

Seed Characteristics

Contained within eucalypt capsules is a mixture of fertile seeds and "packaging" (unfertilised "seeds"). For some species the seed can be readily distinguished from the "packaging" where there is a colour contrast (usually black seed and red or brown "packaging" eg *E. viminalis*). However, the distinction is not always apparent (eg *E. camaldulensis*). Given below are some examples of variation in size of eucalypt seed found from the Melbourne region..

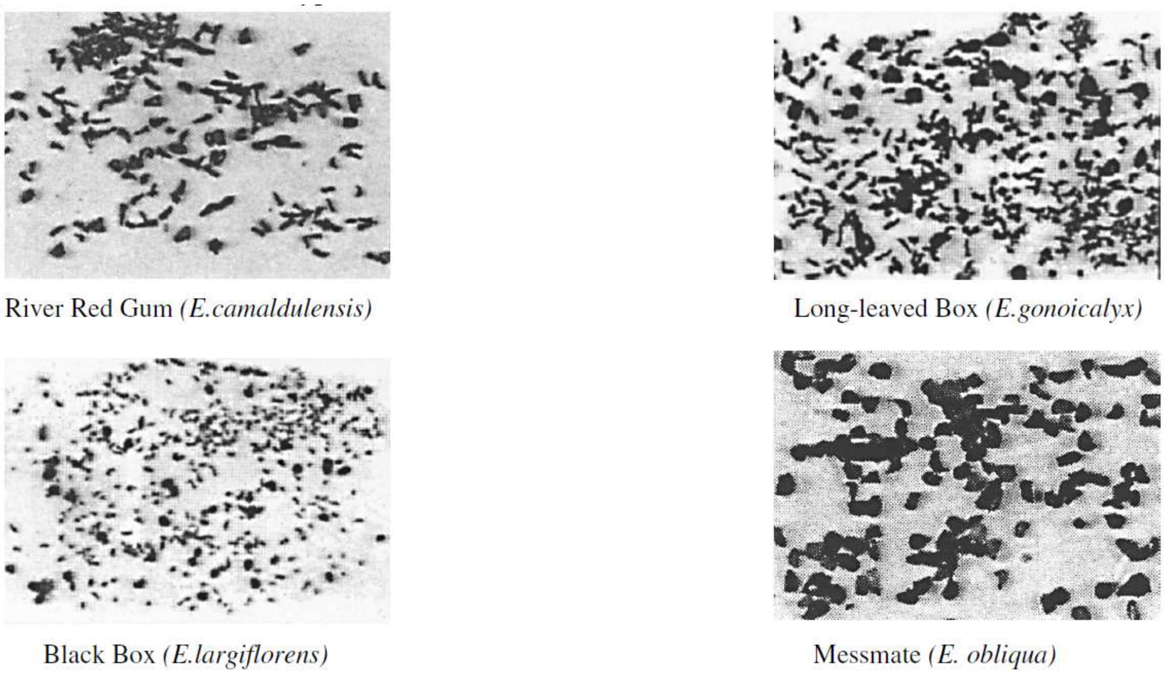

Figure 1: Variation in eucalypt seeds

Seed collection time

The collection of eucalypt seed can vary somewhat within a species as sometimes old fruit can remain on some trees from previous years (eg *E. macrorhyncha*). However, other species drop their seed readily (eg *E. ovata*). As with many genera, variation in the timing of fruit ripeness can be associated with altitude or water availability.

With some eucalypts (eg *E. viminalis*) the seed ripens when the fruit capsules are still green but with other species it is advisable to collect the capsules when they turn grey (eg *E. globoidea*). The viability of seed taken from green capsules, however, is in need of investigation across the genus.

Seed cleaning techniques

For fruit which are tightly closed, seed release can be promoted by separating the capsules from the branches and storing them in a hot dry environment, preferably with good ventilation.

Storing seed in glass jars in the sun can result in the quick release of seed but can also promote fungal growth.

Germination techniques

The germination rate of some species (eg E. obliqua) can be promoted by storing the seed at 4oC for several days. This phenomenon, however requires further investigation.

Generally, eucalypts germinate readily in a standard propagation medium with lower germination rates being achieved for larger-seeded species (eg *E. pauciflora*).

Germination characteristics

The following table has been produced from information obtained from seed collections and germination trials at the Melbourne Indigenous Seedbank. These trials were undertaken using a regime of 24^{o}C day (14 hours)/12oC night (10 hours).

Species	Seed collection time-frame	Approximate time for total germination	Typical germination rate per gram
Eucalyptus baxteri	Variable	35 days	42
Eucalyptus camaldulensis	Variable	27 days	494
Eucalyptus cam phora	? (Includes Dec)	9 days	721
Eucalyptus cephalocarpa	Variable	17 days	333
Eucalyptus cypellocarpa	Jan-June	25 days	372
Eucalyptus dives	Variable	27 days	101
Eucalyptus fulgens	Jun-Feb	6 days	690
Eucalyptus globoidea	July-Jan	28 days	151
Eucalyptus goniocalyx	Variable	22 days	325
Eucalyptus leucoxylon	Oct-Jun	11 days	135
Eucalyptus macrorhyncha	Variable	27 days	33
Eucalyptus melliodora	Variable	14 days	296
Eucalyptus microcarpa	Nov-Aug	14 days	671
Eucalyptus obliqua	Variable	27 days	57
Eucalyptus ovata	Variable	15 days	352

Eucalyptus pauciflora	Apr-Sep	14 days	33
Eucalyptus polyanthemos	Dec-Sep	17 days	47
Eucalyptus pryoriana	Variable	17 days	314
Eucalyptus radiata	Best from Aug-Apr	30 days	255
Eucalyptus rubida	Jan-Sep	40 days	223
Eucalyptus tricarpa	Oct-May	15 days	154
Eucalyptus viminalis	Variable	18 days	154
Eucalyptus yarraensis	Mar-Oct	14 days	84

ABSTRACT

Designing food and habitat trees for urban koalas: tree height, foliage palatability and clonal propagation of *Eucalyptus kabiana*

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Koalas are iconic Australian tree-dwelling marsupials that are classified as vulnerable because of threatening processes that include urban development, habitat fragmentation and inbreeding. Koalas eat the leaves of specific eucalypt trees but urban planners and landowners often prefer to plant smaller trees that pose less risk from falling limbs. We have conducted a long-term project to develop shorter koala-food trees for planting in parklands, schools, streets and gardens. We identified a little-known and geographically-confined species, *Eucalyptus kabiana*, that had potential for urban plantings. We assessed the height of *E. kabiana* trees in cultivation, determined whether their foliage was palatable to koalas, and compared the amenability to vegetative propagation of *E. kabiana* with that of an extensively-propagated related species, *E. tereticornis*. Cultivated *E. kabiana* trees were short, reaching around 3–5 m height after 6 years. Their foliage was highly palatable to koalas, and their cuttings proved to be amenable to propagation. Average rooting percentages for *E. kabiana* cuttings were 31–46%, similar to values obtained with *E. tereticornis* cuttings. Over 600 *E. kabiana* trees have thus far been distributed for planting in wildlife corridors, parklands, schools and gardens. The planting of more koala-food trees will help to alleviate the risks of inbreeding faced by koala populations in fragmented urban landscapes. School plantings also provide opportunities for students to learn about and interact with organisms such as koalas that inhabit the Eucalyptus trees.

Species profile: *Eucalyptus botryoides;* Southern Mahogany or Bangalay

Source: *Euclid*

Description

Tree to 40 m tall. Forming a lignotuber.

Bark rough on trunk and larger limbs in thick, elongated, fibrous, grey or brown slabs; smooth bark predominantly white, cream, or pale brown.

Juvenile growth (coppice or field seedlings to 50 cm): stem rounded or square in cross-section; juvenile leaves petiolate, discolorous, opposite for a few pairs then alternate, ovate to lanceolate, 6.5–11.5 cm long, 2.4–5.8 cm wide, green.

Adult leaves alternate, petiole 1.5–3.5 cm long; blade broadly lanceolate to falcate, 10–22 cm long, 2–7 cm wide, base tapering to petiole, discolorous, glossy, darker green above, paler below, strongly penniveined, densely to very densely reticulate, intramarginal vein parallel to and just within margin or well removed from it, oil glands intersectional or obscure.

Inflorescences axillary unbranched, peduncle broadly flattened, 0.7–1.5 cm long; buds 7, 9 or 11 per umbel, usually sessile, rarely pedicellate (pedicels 0–0.3 cm long). Mature buds oblong to ovoid (0.7–1.4 cm long, 0.4–0.6 cm wide), green to yellow, smooth, hypanthium usually slightly angled, scar present, operculum conical to rounded, stamens inflexed or irregularly flexed, anthers cuboid to oblong, versatile, dorsifixed, dehiscing by longitudinal slits (non-confluent), style long, stigma blunt or tapered, locules 3 or 4, the placentae each with 4 vertical ovule rows. Flowers white.

Fruit sessile or pedicellate (pedicels 0–0.3 cm long), cylindrical or barrel-shaped, 0.6–1.3 cm long, 0.5–0.9 cm wide, often angled longitudinally, disc descending, valves 3 or 4, near rim level or enclosed.

Seed brown, 0.8–2.2 mm long, pyramidal or cuboid or somewhat flattened, edges often toothed, dorsal surface smooth or pitted, hilum ventral or terminal.

Cultivated seedlings (measured at ca node 10): cotyledons bilobed; stems square in cross-section; leaves always petiolate, opposite for 5 or 6 nodes then alternate, ovate-lanceolate, 3.5–11 cm long, 1.3–5.5 cm wide, discolorous, dark green above.

Notes
A small to medium-sized red mahogany tree of south coastal New South Wales and eastern Victoria, from coastal dunes to low subcoastal hills. It has red-brown fibrous bark held in elongated thick strips and strongly discolorous leaves darker green on the upper side, and elongated buds and fruit that vary from being sessile to shortly pedicellate.

Eucalyptus botryoides belongs in Eucalyptus subgenus Symphyomyrtus section Latoangulatae because cotyledons are bilobed, leaves are discolorous and have side-veins at a wide angle to the midrib, buds have 2 opercula and fruit have exserted valves. Within this section, *E. botryoides* is one of seven species forming series Annulares (the red mahoganies), as it has ovules in 6 or 8 rows, seeds cuboid to pyramidal and bark rough over the trunk. The other six species are *E. pellita* from coastal north Queensland and New Guinea, *E. urophylla* from Timor and other islands to the north-west of Australia, *E. notabilis* scattered in coastal and subcoastal New South Wales and south-eastern Queensland, *E. scias* endemic to New South Wales from the coastal and subcoastal ranges, principally from Batemans Bay north to Cessnock with a disjunct occurence east of Tenterfield (subsp. *apoda*), *E. resinifera* (with two subspecies) and *E. robusta* both widespread in coastal New South Wales and Queensland.

Within this group it is closest to *E. robusta* and is distinguished by having smaller buds and fruit, with the fruit lack the joined valves of *E. robusta*.

The other red mahoganies are distinguished by having cup-shaped to funnel-shaped fruit (not cylindrical to oblong like *E. botryoides*).

In the northern end of its distribution, *E. botryoides* intergrades with *E. saligna*, which is mostly smooth-barked, and some populations of 'half-barks' cannot be ascribed to either species, e.g. those in Kangaroo Valley.

Flowering Time
Flowering has been recorded in December, January and February.

Produces timber suitable for structural purposes, and is a useful honey species. Also grown as an ornamental plant, particularly in coastal areas close to the sea.

In Western Australia Eucalyptus botryoides has escaped from plantings and become naturalized (Hussey et al., 1997), e.g. near Hamel on the sandplain south of Perth. In Victoria Carr et al. (1992) regard this species as an environmental weed posing a serious risk to heath, dry sclerophyll forest and woodland, and lowland grassland, noting it as already widespread but occurring in small populations.

Origin of Name
Eucalyptus botryoides: Greek botrys, like a bunch of grapes, alluding to the clustered fruits..

Australia's gum trees 'at risk'

Source: NERP Environmental Decisions Hub Media Release; December 16, 2013

Many of Australia's iconic eucalypt ecosystems could change beyond recognition due to increased climate stress.

Research at the National Environmental Research Program's (NERP) Environmental Decisions Hub has found that heat waves, droughts and floods expected under climate change will alter environmental conditions so much that many eucalypts will no longer survive in their native ranges. Replanting is unlikely to help woodlands and forests persist, the scientists warn.

"Trees are vulnerable to climate change," says lead author Dr Nathalie Butt of the NERP Environmental Decisions Hub and The University of Queensland (UQ). "This is due to their long regeneration times and the relatively short dispersal distances of their seeds.

"Many of Australia's approximately 750 eucalypt species may not be able to keep up with climate change sufficiently to avoid heavy losses – and these will in turn have cascading impacts on local wildlife and other plants," she adds.

To find out whether Australia's various eucalypts can withstand likely climate changes, the NERP researchers tested different climate scenarios based on those used in the latest Intergovernmental Panel on Climate Change (IPCC) report.
"Previous extreme droughts have caused widespread dieback in eucalypts in some regions. This suggests that some, such as savannah species in northern Queensland, are already at their limits," Dr Butt says.

"Climate change predictions of a shift to longer, drier periods in coming decades could therefore tip our eucalypts over the edge in many regions."
In the study, the researchers applied mid---range and extreme climate scenarios to 108 eucalypt species and grouped them by climate region across Australia.
Dr Butt says that models predict that climate changes will drive large shifts in the trees' distribution. "Large areas of central Australia will become unsustainable for eucalypts, due to extensive summer drying and more frequent droughts," she says. "Trees may gradually shift their ranges towards the coasts where growing conditions are more favourable, or die out due to drought.

"However, colonisation of new areas may not be possible as land is cleared for farming."

Dr Butt says the study shows that reforestation or restoration plans to save biodiversity and environment may not always be effective: "We can't assume we can simply restore ecosystems by reforestation. Replanting the same eucalypt species won't help if the climate conditions are no longer suitable.

"This research will help inform the large scale restoration activities proposed by existing and future Australian governments."

"We need to think about how to help our local trees and plants to buffer climate stress," Dr Butt says. "We also need to focus on how to reduce the impacts of climate change, by cutting carbon emissions and reducing other environmental stresses on our native trees."

The study "Eucalypts face increasing climate stress" by Nathalie Butt, Laura J. Pollock and Clive A. McAlpine was published in Ecology and Evolution. See: http://bit.ly/189ivsX

The Australian Government funds the National Environmental Research Program (NERP) to inform evidence---based policy and sustainable management of the Australian environment

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