

# Australian Plants

Registered by Australia Post  
Publication No. PP226253/00017

September, 2005  
Vol. 23, No. 184

**\$3.95**



To date we have had articles about the northern and southern 'ends' of Queensland, so this issue we focus on the 'middle' - namely some parts of Central Queensland. We continue with the second part of Ann McHugh's article on the Blackdown Tableland west of Rockhampton, as well as Tondoon Botanic Garden designed by Lawrie Smith, in Gladstone. Shirley and Colin Cattle write about their garden in Rollingstone near Townsville. The climate of this region is dryer than points further north, resulting in different flora. Hopefully this will inspire some of our readers to visit parts of Australia not as well known for their botanical wonders but nevertheless revealing some fascinating places.

Australian Plants is about plants, gardens, parks and plant communities from all over the country. We would love to hear from places not usually covered or written about. The articles from such places as Gladstone, Blackdown Tableland and the Eyre Peninsula resulted from a few phone calls and some enthusiastic local Society Groups. Do you live near, have you visited (or do you own) a memorable garden, National Park, regional park or other place of botanical or horticultural interest? If so, please contact the editorial team of Australian Plants and we can see about getting it into print.

Currently we are having to chase people for about 8 out of every 10 articles in the magazine, which though enjoyable, can be onerous for 12 months of the year. More articles in would help in getting the magazine out on time.

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Front cover: ***Thysanotus tuberosus***, Blackdown Tableland National Park, Qld - photo: Ann McHugh (p. 123)

Back cover: ***Petrophile canescens*** cones, Blackdown Tableland National Park, Qld - photo: Ann McHugh (p. 130)

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# *Native grasses - a natural choice for Australian agriculture*

Dr Christine Davies and Dr Ted Lefroy

This research has set out to domesticate an Australian native grass to produce Australia's first perennial grain crop. Perennial (long-lived) grain crops offer a new solution to the long-standing problems of salinity and soil erosion associated with conventional cropping systems based on annual plants.

This project arose from the conference *Agriculture as a Mimic of Natural Ecosystems* hosted by the University of Western Australia in 1997. The purpose of the conference was to see how we could develop an Australian agriculture based on native plants.

One of the big challenges facing Australian agriculture is the management of salinity. The problem is that high seed-yielding annual crop plants like wheat and barley make incomplete use of annual rainfall. Excess rainfall accumulates in the soil and mobilises ancient stores of salt. Australia's native vegetation on the other hand is well adapted to ancient soils and highly variable rainfall. The woodlands and heath of southern Australia are dominated by plants that are long-lived and use virtually all the rainfall. The disadvantage with basing agriculture on perennial plants is that they grow more slowly than annual plants and produce less harvestable material each year.

The starting point for this project was the observation that there are two forms of perennial plant; woody and herbaceous, and within each of these there are two potential end products; vegetative (leaves and stems) or reproductive (seeds and fruit), giving us four possible production systems. Three of these already exist in Australia in the form of forestry (woody and vegetative), perennial pastures (herbaceous and vegetative) and horticulture (woody and herbaceous plants grown for reproductive yield). The system not currently exploited commercially is perennial herbaceous plants grown for seed yield.

The concept of perennial grain crops presents major biological and agronomic challenges. The biological challenge is that perennial crops appear to contradict the fundamental principle of biology that plants partition their resources either towards reproduction or perenniality, but not both. The agronomic challenge is demonstrating an exception to a 10,000 year-old rule that successful grain production is based on fitting high seed-yielding annual grasses into a short seasonal window to avoid climatic extremes. Had the proposal been based on ecological principles or the history of agriculture, it may not have got very far.

**Continued on page 105**



**Cattle's Garden at  
Rollingstone - see page 102**

**Above:**

*Melaleuca leucadendra* in the  
Lagoon near the house.

**Left:**

Elkhorn ferns and orchids  
planted in tree stumps of  
*Corymbia tessellaris*.

The white trunk of *Corymbia  
tessellaris* can be seen on the  
right.

**Below:** Rollingstone Creek  
Photos: S Cattle





**Top Left:**  
*Bowenia serrulata*  
Byfield Fern

**Above:**  
*Bombax ceiba* with Mango and  
Lychee orchard in background



**Below Left:**  
Pond with white *Nymphaea*  
Water Lilies, *Aristolochia tagala*  
vine on fence

**Below Left:**  
*Grevillea formosa*  
Mt Brockman Grevillea

**Below:**  
*Licuala ramsayi*  
Mission Beach Fan Palm  
Photos: S Cattle



## Our Garden 47:

### Cattles' Garden at Rollingstone

Colin and Shirley Cattle

Our property is situated at Rollingstone in tropical North Queensland, midway between Townsville (dry tropics) and Ingham (wet tropics). Winter temperatures rarely fall below 12°C and summers are in the 30°s. There are two seasons, the wet (summer) and the dry. Our 60 acre property has about 40 acres of relatively untouched native bush, comprising four distinct habitats.

The seasonally flooded *Melaleuca* and *Pandanus* wetland is dominated by *Melaleuca viridiflora* with cream bottle brush flowers, occasionally interspersed with red flowered forms. These trees host the native orchid *Dendrobium canaliculatum* with its sprays of white flowers. *Melastoma* sp. with mauve flowers grows as under-storey shrubs and the Red Blood Lily, *Haemodorum coccineum* is evident in summer. *Nymphaea* Water Lilies flower blue and white in ponded water.

The woodland areas comprise of eucalypts, wattles and grevilleas, being dominated by the magnificent *Corymbia tessellaris* with its base of dark tessellated bark and smooth white upper trunk and branches. The Black Wattle, *Acacia melanoxylon*, is a large tree which provides good timber and is a food source for many animals and birds. The Orange Grevillea, *Grevillea pteridifolia*, is a slender small tree that is very showy over a long period. *Planchonia careya*, the Cocky Apple, grows in abundance.

Between the open forest and the creek is an area of vine forest, with many rampant vines including the Giant Matchbox Bean, *Mucuna gigantea*, so called because the pioneers used to hollow out their large seeds, hinge them, and use them as containers. The native Sandpaper Fig, *Ficus opposita*, abounds in this area.

The creek is dominated by large *Melaleuca leucadendra*, red flowered *Callistemon viminalis*, and *Pongamia pinnata*. The Native Olive, *Chionanthus ramiflorus*, and Native Ebony, *Diospyros ferrea*, also abound. In the wet season the creek is a sight to behold, but in the dry it becomes a series of rocky waterholes.

The 1.5 acres around the house is landscaped with native and exotic species under a canopy of the mature native trees and palms which provide much needed shade in our climate. It includes a rainforest area, a seasonally dry lagoon with an enormous *Melaleuca*, and a park-like area featuring mature red flowering *Bombax ceiba* with their spectacular thorny trunks. *Grevillea baileyana*, *Melicope elleryana*, and a variety of large palms also grow here.

Shirley Cattle was a member of SGAP Queensland in Townsville for 15 years.

Her garden at Rollingstone will be open as part of:

**AUSTRALIA'S OPEN GARDEN SCHEME** on 12<sup>th</sup>-13<sup>th</sup> August 2006.

During the wet season many of these plants self seed and are allowed to grow wherever possible. When the lagoon fills in the wet, it is covered with water-lilies and is home to native fish, frogs, turtles and eels. Pandanus overhang the water.

To add colour to the garden, it is planted with an under-storey of bromeliads, cordylines, gingers, crotons and cycads. This tropical look is enhanced by Elkhorn ferns and orchids planted in tree stumps. A large Byfield Fern, *Bowenia serrulata*, is a feature. *Bowenia serrulata* is a native cycad with an unfortunate common name.

Our property is home to a vast array of native animals and birds. Wallabies are seen daily and bandicoots and flying foxes are prevalent at night. Goannas, frill-necked lizards and snakes are common in the bush areas and we see the occasional echidna and blue-tongue lizard.

Butterflies are encouraged with plantings of *Melicope* species (to attract the Dunk Island Butterfly) and *Aristolochia tagala* vines (to attract the Cairns Birdwing butterfly). These are spectacular large butterflies abundant in summer.

To encourage nectar feeding birds we have planted many grevilleas. We have found that the tree types are far more successful than some of ground covering and shrub types, which grow well until the heat and humidity of summer causes their demise.

Our property has such a diversity of flora and fauna that each day brings new discoveries as we walk along bush paths or visit the lagoon or the creek. The bird life is ever changing as the migratory birds visit a while or just pass through.

It is a beautiful place to live.

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## Dwarf Acacias in WA

by Hugh Seeds

There are several Acacias that are low growing that do well in gardens in Western Australia. These include: *Acacia glaucoptera*, *Acacia lasiocarpa* var. *sedifolia*, *Acacia phaeocalyx*, *Acacia restiacea* and *Acacia erinacea*

*Acacia erinacea* grows flat on the ground among the leaf litter beneath the Wandoo and I call it the Carpet Wattle. When showing some botanists around a patch of bush I told them *You are standing on the most interesting plant here!* It is spiny so don't walk over it barefoot.

*Acacia glaucoptera* is from down south and has grey green or blue grey "leaves", the tips of the phyllodes being bright red-purple. The flowers are little balls in the axils of the lobes all along the stems. *Acacia alata* is rather like *A. glaucoptera* but not so colourful. *Acacia hemiteles* is taller but floriferous.

*Acacia phaeocalyx* has triangular phyllodes. The stems of *Acacia restiacea* are like rushes and flowers come out all along the bare stems.



# **Cattle's Garden at Rollingstone**

see page 102

## **Above:**

*Corymbia ptychocarpa* - Swamp Bloodwood.

## **Left:**

*Wodyetia bifurcata*

Fox tail palm from Cape York

**Below:** *Deplanchea tetraphylla*

Photos: S Cattle



## Native grasses

continued from page 99

However a review of research into perennial grain crops around the world produced two notable conclusions: 1) long life and high seed yield are not necessarily mutually exclusive, with some experimental perennial crops yielding in excess of 1 tonne per hectare of grain in the USA, and 2) there are likely to be niches in agricultural landscapes where low grain yield from a perennial crop could be complemented by its grazing value.

These conclusions come out of international research on nine perennial grain crops. Two of these have a history of cultivation dating back 800–1,000 years. They are intermediate wheatgrass (*Thinopyrum intermedium*), recently released as the cultivar Triga in the USA which was used for human consumption in Turkey, Armenia and the Caucasus mountains during Byzantine times, and Lyme grass (*Leymus arenarius*), used as a food grain in Iceland during the time of the Vikings. The other seven are the products of modern selection and breeding programs in Europe and North America.

Perennial grain crops have two potential advantages over annual crops in the sustainable management of soils and landscapes. They do not require annual cultivation, and being perennial they make more complete use of annual rainfall.

The trade-off is that grain yields will not be as high as that of annuals. It is hoped that their dual role as grain and grazing plants will help to offset lower returns from seed harvest. In this way it is planned to produce a plant tailored to a particular niche, the arable mid to upper slopes of the medium to high rainfall zone where there has been an increase in the area under cropping in recent years in response to declining wool prices, but where recharge and soil erosion represent significant risks to sustainable land use. This niche is estimated to cover some 3–5 million hectares across the Australian grain belt. Under dual-purpose perennial grain crops, this land could remain commercially viable and environmentally sustainable.

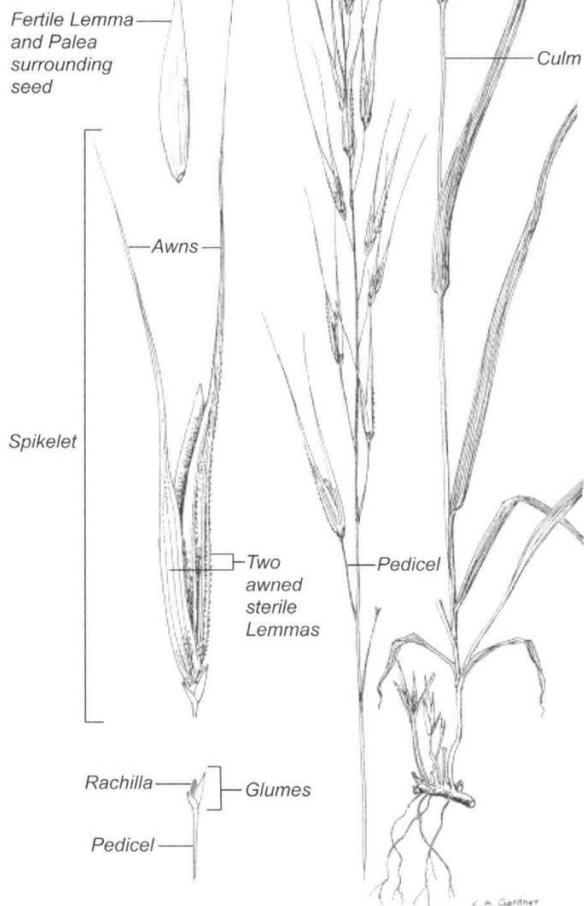
Our team identified the native species weeping rice grass (*Microlaena stipoides*) as a promising candidate on the basis of seed size and wide distribution. Forty six accessions of microlaena were collected from southern Queensland through NSW to south western WA and assessed for seed yield and its components (seed weight, seed set, culm number and spikelet number per culm) to quantify potentially useful variation in the species.

A high degree of variability was found to exist, with a 20-fold range in seed yield (0.1–2.4 g/plant), 5-fold range in seed weight (129–666 mg per 100 seeds), 8-fold range in seed set (12–98%), 5-fold range in culm number (11–59 per plant) and a 2-fold range in spikelet number (14–30 per culm).

The range in seed yield and its components suggests there is sufficient variation within microlaena to make selections for higher yielding lines. This variation will enable breeders to exploit genetic diversity more efficiently and identify useful accessions for further work. High priority traits for future work include synchronous maturity and resistance to shattering.

The research is supported by the Rural Industries R&D Corporation and the Grains R&D Corporation.

# *Microlaena stipoides*



**Above: Figure 1.** Line drawing of *Microlaena stipoides*. Modified from Gardner CA (1952) *Flora of Western Australia*. Gramineae. Volume 1. (Government Printer: Perth)

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## **Left: Figure 2.**

Seed of *Microlaena stipoides* (left) shown with long grain rice.



# What's in a Name?

The Gender of *Amyema* Mistletoes with a comparison of the Botanical and Zoological nomenclature codes. \_\_\_\_\_ John T. St. Leger Moss

## Summary

A case is made in support of a proposal for changing the gender usage of *Amyema* (Van Tieghem, 1894) from neuter to the feminine, based on a review of the author's paper, recent literature and the current International Code of Botanical Nomenclature. A brief comparison is made with the corresponding gender situation of the International Code of Zoological Nomenclature.

## Introduction

Some years ago I wrote a paper on the mistletoe host plant associations of the Barakula, Columboola and Gurulmundi region of south-east Queensland. This subsequently appeared in Volume 36 of the Queensland Naturalist in December 1998. The paper was not primarily about butterflies, but about which shrubs and trees were parasitised by certain mistletoes and which mistletoes themselves were parasitised by other mistletoes. The Abstract records — 'Sixteen of the 18 mistletoe species and five of the 6 santalads (root parasites) known from the Murilla and Chinchilla shires were recorded during a field trip of the Queensland Naturalists' Club during September/October 1997. Additionally 90 individual mistletoe/host plant associations were observed (including 29 with acacias) of which only 20 had previously been recorded for the area. Some of these were complex multiple parasitisms'.

When I submitted the paper for publication, an anonymous referee pointed out that the gender of one of the mistletoe genera, *Amyema*, was in contention. I had assumed it was neuter, as it had appeared in Volume 22 of the Flora of Australia (1984) but in my discussions with Dr. Bryan Barlow, the Australian authority on mistletoes at that time (and also author of the Loranthaceae section in the Flora), I learned that he had revised his opinion and was now treating *Amyema* as feminine.

## Feminine vs. Neuter

Barlow and most other authorities originally had considered *Amyema*, taken from the Classical Greek, to be neuter and there was a word 'Amyema' in Greek which was neuter. However, it was later discovered that the author of *Amyema*, the European botanist P. van Tieghem had constructed his word AMYEMA from two Greek roots and had intended it to be feminine. He apparently had no knowledge of the existing word 'Amyema' nor its gender (Van Tieghem, 1894).

In any case *Amyema* was treated by various mistletoe authorities including W.F. Blakely (1923) as neuter until Barlow's 1992 *Amyema* paper when he noted van Tieghem's construction and erection of the genus *Amyema* as feminine and stated that "In accordance with Article 76 of the International Code of Botanical Nomenclature (ICBN), adopted in August 1987, the name retains the gender assigned by Van Tieghem and in this treatment the adjectival epithets cited are accordingly feminine".

After this, two schools arose for the differing points of view – one based at the National Herbarium in Canberra using *Amyema* in the feminine gender and one based at the Queensland Herbarium adhering to the neuter.

Naturally the referee of my paper from the Queensland Herbarium took issue with me on the manuscript where I had followed Barlow and used feminine endings for the adjectival specific names e.g. *Amyema linophylla*, and recommended I use the neuter ending i.e. *A. linophyllum*. In following discussions with the journal editor I agreed to follow the local school and go neuter. (I can't quite remember whether at the time I was put under any duress, but I recall the editor saying that the referee was quite a senior botanist!)

I knew I couldn't please everyone, and following the publication I admitted to Bryan Barlow that I had followed the old metaphor 'When in Rome' etc. Fortunately he was only mildly chastising, and I'm sure it didn't compromise our relationship nor that with Paul Downey, his young and energetic PhD student, with whom I have had subsequent collaboration, and who is currently writing a definitive work on all the Australian mistletoes. Paul has confirmed (pers. com.) that the work, to be published in 2005, will be using *Amyema* in the feminine gender (Downey, in prep.)

The reason for going into some detail with the story should be apparent to those who have noticed a discrepancy between Braby (2000) and the section on mistletoes that I wrote in the butterfly host plant booklet published by the Butterfly and Other Invertebrates Club Inc. (2002). It can be seen that Michael Braby, who was working for the CSIRO in Canberra during preparation of a milestone two volume butterfly book, followed the National Herbarium *Amyema* nomenclature, whereas I continued to follow the 'Brisbane line' with neuter endings. In view of the fact that the latest (2002) Queensland Herbarium plant census used neuter endings I decided to continue with my original decision (i.e. neuter specific epithet endings) for the host plant booklet.

### **Comparison with ICZN**

What has prompted me to resurrect this issue, was a note in a recent News Bulletin of the Queensland Entomological Society, wherein this issue of consistency of gender endings is discussed (Anonymous, 2003). The author of the note points out that there is a mandatory requirement under the terms of Article 31(b) of the current International Code of Zoological Nomenclature (ICZN) 1985 that "the gender of an adjectival specific or subspecific (species and subspecies) name agree with the gender of the genus with which it is (currently) linked". He further points out that the ICZN rules state that when moving a species from one genus to another, the gender of the species name in the new combination must be altered to match the gender of the new genus.

However, three recent major publications on Australian Lepidoptera, namely Braby (2000), the Lepidoptera Checklist (1996) and the Zoological Catalogue (2001) 'in the interests of nomenclatorial stability' have opted to use 'the species group names in the form in which they were originally spelled, irrespective of the gender of the genus with which they are currently associated, unless other provisions of the code apply'. The authors of these three 'official' publications further justify this variant position by pointing out that *the gender of generic names is often doubtful or arguable and few biologists today have the classical background to determine the origins of generic or specific names.*

### Interpretation of the botanical code

Whilst there appears to be some flexibility, for valid purposes, within the gender aspect of the ICZN, the same cannot be said about the ICBN, which appears more rigid, and yet there is disagreement in at least this one case. Barlow's contention on Van Tieghem's feminine designation is a strong argument which is supported by article 76 of the 1987 Code (Greuter *et al*, 1988). The neuter option relies on a more narrow interpretation, based solely on the pre-existence of a Classical Greek word, which on transliteration coincidentally had similar meaning and (unfortunately) the same spelling as Van Tieghem's constructed word.

As most Latin words ending in 'a' are feminine, assumptions may be made that a neuter specific epithet (ending '-um') is incorrect. It is apparent that people tend to prefer to use scientific/botanical names that are logical and easy to pronounce and spell. In the case in point, *Amyema linophylla* vs. *Amyema linophyllum*, there is no doubt that the feminine word is a lot softer on the ear and looks correct. (The masculine latinised equivalent, 'linophyllus', existed prior to *Amyema* when the genus was *Loranthus*.) However, the majority of Classical Greek words ending in '-ma' are neuter. Nicholson (1994) list (inter alia) the suffix -myema and the derived noun *Amyema* (from the Classical Greek root myeo) as neuter. However, this origin does not of itself prove nor even imply a botanical tradition.

### Conclusion

In regard to the above, Article 62 of the current ICBN (Greuter *et al*, 2000) states "A generic name retains the gender assigned by botanical tradition, irrespective of classical usage or the author's original usage. A generic name without a botanical tradition retains the gender assigned by its author." However, on reading Van Tieghem's original paper, and noting the (feminine) gender of the new combinations of his designated species, it appears that Article 62 as applied to his genus *Amyema*, which having no proven botanical tradition, should allow for the application or rather provide a reinstatement of the feminine gender, as per his construction.

Thus I believe a valid case can be made for the (future) use of *Amyema* in the feminine, and in this regard I support Barlow's 1992 contention.

## Acknowledgements

I wish to thank Peter Bostock, botanist, of the Queensland Herbarium, for helpful discussions and assistance with locating references and Daphne Bowden for typing several drafts of the manuscript.

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# The Tondoon Story

Lawrence S Smith, LANDPLAN Landscape Architects

In June 1975, the early days of Gladstone's first industrial boom period, an open space planning study was done in conjunction with the updating of the town plan to ensure that the expected growth of the city was logical and appropriate for the hilly terrain. The study identified a tract of land at Toolooa & Glen Eden centred around Mount Biondello and Tondoon Creek as a major open space node with regional environmental and botanic significance. The land was linked to the city centre along a proposed parkway corridor that was to take the future Gladstone - Benaraby highway.

In 1978 Landplan was commissioned to prepare a Strategic Plan for the subject site that investigated, among other uses, the establishment of a Botanic Gardens and the possible relocation of the Showgrounds to the site. The Council caught the vision and determined that a Botanic Gardens was an excellent option for progressive development of the site and for the long term benefit of the city. A Master Plan was subsequently commissioned in 1980 and effectively this commenced the establishment process.

One of the fortunate aspects of the initial planning phase was the results of a 1984 report on the status of collections of Native Plants in the existing Botanic Gardens and Arboreta in Australia which highlighted the need for establishing Botanic Gardens in this and other Australian regions in order to research and develop the endemic flora. Lawrie attended a related planning symposium, which resulted in the commencement of the first two of the proposed Regional Botanic Gardens – Coff's Harbour and Gladstone. Since then these two gardens have developed separately but along similar lines and together have set the benchmark for many gardens that have followed.

Planning and creating Tondoon was in many ways a community experience involving many local people who were enthusiastic about identifying the specific local vegetation, determining its botanic qualities and experimenting with its potential for use in ornamental horticulture. The local branch of the Society for Growing Australian Plants was one of the beneficiaries of this process as people like Norm Gibson and Ruth Crossan became deeply involved with the process. Others like Lloyd Curtis and Noel Wootton of Queensland Alumina were instrumental in assisting from the corporate sector. Mayor Col Brown, Councillors and officers like planner Trevor Gargan were similarly supportive. It was great to work for many years in association with the first curator Neil Kershaw, together we were able to build on the newly completed construction works to establish the many and varied plant communities all the while ensuring the botanical relevance of the collection.

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Landscape architect Lawrie Smith, managing director of Landplan has been involved with the planning and development of Tondoon since its inception. Lawrie Smith was President of SGAP Queensland from 2001-2003, then Secretary for the 2004-2005 year.

Later, Curator Lucy Sutherland was able to capitalise on this to organise a range of innovative interpretation programmes and methods of the maturing plants. Without this collective support Tondoon could never have achieved the excellence for which it is now renowned.

Detail design and documentation followed progressively from 1981-1984 after the master planning process, with several stages of construction leading to opening day in 1988 - Tondoon was Gladstone's premier project celebrating the Bicentenary of Australia. The site is typical of the region with steep rocky slopes covered by open sclerophyll forest contrasting with patches of dry scrub in the deeper more protected valleys. However with the massive earthworks required to form the lake and the undulating lower gardens we were able to plan and create a user friendly garden which has become very attractive to stroll around. For the stout hearted the steeper access pathways to and along the upper slopes provide a wealth of diverse habitats as well as extensive views over the expanding city and harbour.

Many people were involved in the design and construction phase assisting me as the landscape architect. David Hockings was involved with site survey and vegetation identification and mapping. Perhaps the most important was Milton Blain (Blain Bremner and Williams) a gifted local engineer who ensured that my vision of an extensive lake and series of cascades to moderate the sometimes harsh dry climatic conditions was achievable. The lake was impounded once again by the restored Tondoon Dam but with the spillway reduced in level. This was done to allow the rich alluvial flats to be developed as primary display gardens rather than be covered by water. Cascades flowing through the gardens and upper gullies recycle the lake water ensuring aeration and optimum water quality; at the same time they add moisture and the cooling sounds of flowing water to enhance the experience of visitors.

Since opening day the Gardens have continued to develop and mature with new facilities such as the Visitor Centre as well as gardens added from time to time. The Master Plan has continued to be used to guide the development of Tondoon and it is pleasing to see that the initial concepts have stood the test of time. Like all similar projects Tondoon will never be finished but it provides an invaluable legacy to hand on to future generations, which will ensure that the unique characteristics of the regional flora will be appreciated and will influence the landscape of the continuing development of the city and the region.



**Above:** The Tondoon Forecourt

Photo: Tiki Hanson

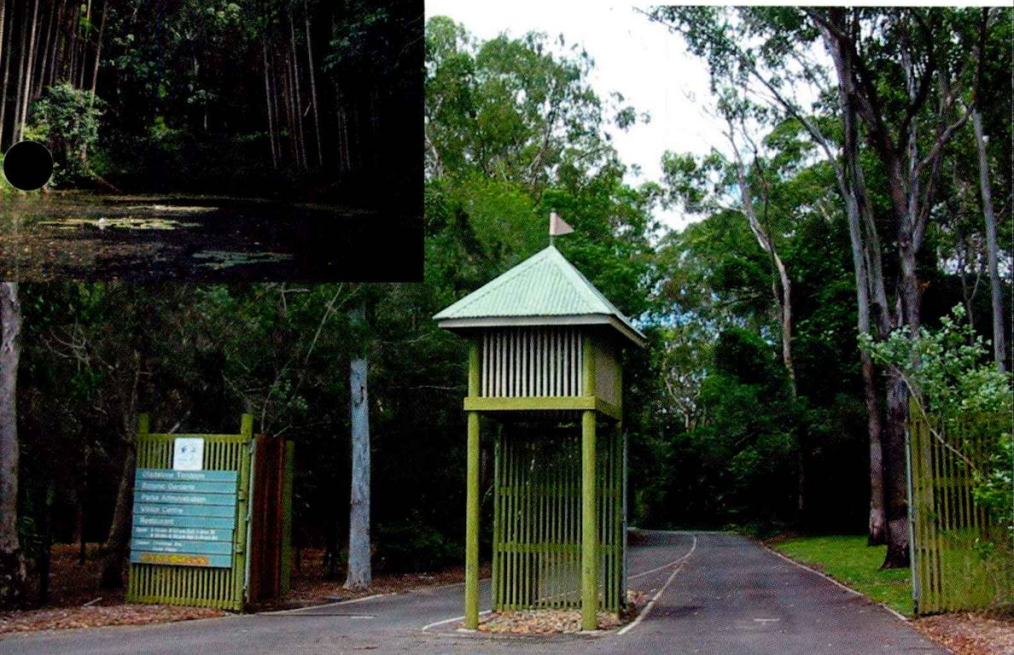


**Left:** Central Pond with Palms and *Elaeocarpus grandis*

Photo: Pam Tanner

**Below:** Entrance to Tondoon

Photo: Tiki Hanson





**Above:**  
Cafe over Lake Tondoon

**Left:**  
Outside Administration Centre  
Photos: T Hanson

**Below:**  
Outside Administration Centre  
See page 117 Photo: P Tanner



# *A walk through Tondoon Botanic Gardens*

Pam Tanner SGAP Gladstone Branch.

Welcome to Tondoon Botanic Gardens which are situated at Gladstone, on Queensland's central coast. Before we wander through the gardens, let me briefly fill you in with a bit of their history. Covering about 83 hectares, quite a bit of which is still in it's natural state, these beautiful native gardens were designed by landscaper extraordinaire Brisbane's Lawrie Smith, and brought into fruition by Neil Kershaw from Rockhampton and his technical officer David Warmington. Now carefully nurtured by Tondoon's Curator Brent Braddick, these gardens were officially opened in 1988.

What is now Tondoon lake, used to be the Gladstone water supply. The original dam wall is still in place. The gardens themselves slope up to Mt Biondella, and beds on the lower part of the gardens represent different areas from around our part of Port Curtis. The wet tropical areas are to be found further up the slope. These magnificent gardens are financed and run by the Gladstone City Council.

History lesson over. From what was dry woodland of mainly eucalypts and acacias, these superb gardens have been brought to a cool green paradise. Come in through the large open wooden gates and on the right patches of sunlit grass peep through the areas of palms, ferns, and trees with hanging vines, on the left are lovely dry area trees, Pandanus and a patch of livistonas. A roadway leads off to the left to the Arboretum, with children's playground, picnic area, Japanese tea house (the gardens for which are still under construction) and the sculpture 'Vitae-Morte'. Unlike the prime display area, this area, and a tropical fruit area, out of view behind the old dam wall are the only two areas which are not purely native.

While we are still here, let us go on a walk to the toilet block, this may seem a very strange place to take you, but they are somewhat of a surprise. What looks like a large tree and shrub covered hill actually hides the block itself, and when you go inside, there are garden beds, and oh yes, toilets. There used to be hanging baskets of ferns until people decided they would look very nice at their place. There are still a few, heavily chained to the beams. Surely these must be one of Australia's 'Beautiful Toilets'. I was assisting with a bus load of Seniors one day and was asked by a dear old lady where 'it' was. She looked very distressed when I showed her the way, and said, *I don't REALLY have to go in the bushes do I?*



**Above:** Subtropical Rainforest.  
See page 119 Photo: T Hanson

**Right:** *Elaeocarpus grandis*  
fruit and leaves.

**Below Right:** *Bowenia serrulata*, Byfield Fern

**Bottom Right:** *Barklya syringifolia*  
See page 119 Photos: P Tanner

**Below:** Mt Castle Tower bed.  
See page 117 Photo: T Hanson



Tondoon lake runs almost the full length of the lower parts of the gardens. It is on the left as we pass the tear shaped car park on the right, beautifully shaded by different trees and shrubs. Between us and the lake are lawn areas and growing in these areas are *Eucalyptus tereticornis*, all of a uniform size which began life when the dam was made redundant. In a building overhanging the lake there is a visitor information centre which also houses an art gallery, toilet facilities and a café where people can eat, view the turtles and different water birds. Jacanas, Magpie Geese and Jabiru visit during summer. (Photo page 114). Magpies, crows, Blue Winged and Laughing Kookaburra's like to join people having their lunch, and will even steal it if you are not ever watchful. The Blue Faced Honeyeaters or Banana Birds featured in a British documentary called 'Clever Dicks'. They had learned to open the lids on the sugar bowls and help themselves. This was frowned upon by the Health Department, and the sugar is now given out in packages. The gardens policy is against feeding the birds, our food is not good for them and there is food aplenty all around them in the gardens. The administration building, herbarium, work areas and nursery are to the right across the courtyard. There is a huge, beautiful python which lives around this area, upsetting the birds no end when it decides to go for a wander.

We now follow the path beside the lake, across a bridge, through the Orientation Shelter, into the prime display area for plants from Port Curtis area. Specifically named beds are in this section, each bed has plants collected only from that particular area. Once a month Brent Braddick the Curator takes a group of herbarium volunteers on field trips to different areas around the Port Curtis region. Plant lists are updated with each field trip and seeds, cuttings and small plants, (also specimens for our Norm Gibson Herbarium) are collected. These are then taken to the nursery and grown up and lovingly tended by Julie Keyes, until they are planted out in their correct beds. An example of this is the 'Mt Castletower' bed at which we have arrived, passing the lower area of the 'Dan Dan Scrub' SF 53. (Photo on page 116.)

Mt Castletower is situated at the northern end of the Many Peaks range SW of Gladstone. Heath plants grow well on the steep granite slopes as the soil is very low in nutrients. The garden bed has been built high with large boulders, to represent this. *Grevillea venusta* and *G. banksii* along with *Brachychiton bidwillii*, *Leptospermum neglectum*, *Hibbertia velutina*, and the superb, rare *Boronia bella* attract masses of honey-eaters. There are also small prickly herbs, shrubs and beautiful native grasses.

Let's now follow the path to the right which takes us past the 'Callide' bed (Callide is West of Gladstone almost to Biloela), where *Callistemon viminalis* and *Brachychiton australis* dominate the other species, then on to 'Rundle Range'. *Elaeocarpus obovatus* is just about to burst into its lovely little frilly bell shaped flowers, *Croton acronychioides* is showing off it's occasional orangey-red leaves. Also growing in this area are *Alectryon connatus* and *Pleiogynium timorense* or Burdekan plum. This has dark reddy-purple fruit covering a large seed capsule and is one of the bush tucker foods, very nice when ripe, tends to make your face pucker up if its not (very sour).



**Above:**  
Zamia & Xanthorrhoea Beds

**Left:**  
A Zamia in the Gardens

**Below:**  
Wet Tropics Area

**Below Left:**  
Fan Palms

See page 119

Photos: T Hanson



Next comes the 'Beecher' area SF150. This is an area well known to me, my home territory and where quite a few of my favourite plants grow. Beecher is about 12 km west of Gladstone, beside the Calliope river, where patches of dry rainforest grow in gullies running down from Mt Beecher. *Flindersia schottiana* tower over Peanut Trees (the beautiful *Sterculia quadrifida*, another of the bush tucker trees), *Ixora queenslandica*, *Diospyros ferrea* var. *geminata*, *Murraya ovatifoliolata*, *Citriobatus spinescens*, in which small birds love to nest (the name is self explanatory, the spines deters snakes from climbing to steal their eggs and young), and two of my special favourites, *Geijera salicifolia* which has beautifully aromatic leaves when crushed and *Polyscias elegans*, commonly known as celery wood.

As we walk up towards the Queensland rainforest areas we pass the Sub Tropical Rainforest area on the left. (Photo on page 116). Gladstone's floral emblem, the stunning golden flowering *Barklya syringifolia*, or 'crown of gold' is displayed in these gardens as well as in the Dan Dan Scrub bed. (Photo on page 116). We have now walked in a circle around the prime display area. In the centre of this circle are large ponds which are filled by the creek that flows down from the wetter areas of the forests. The water is pumped up from Tondoon lake and eventually ends up back from whence it came. This keeps the area cool and humid. The creek does flow naturally when we get heavy rain, which isn't very often. The ponds are overhung by *Ficus*, *Lomandra* and ferns, and at one end of one of the ponds is a thick stand of palms and an enormous *Elaeocarpus grandis*, whose beautiful red leaves and round blue fruit on the ground, are a dead give away as to where the tree is trying to hide. (Photo on page 116). The Byfield bed runs along beside the central pond which has growing in it *Bowenia serrulata*, the rare and threatened Byfield Fern, which is in fact a cycad. (Photo on pages 101 and 116). Also *Bowenia spectabilis*, or *Zamia* Fern, to name just a few of the species. On the opposite side of the lake there is a section of lawn, the beds on either side of this contain *Xanthorrhoea*, *Zamia* and *Cycas* species, none of these from specific areas.

Let's now go back onto the main track which takes us up past the Rare and Threatened bed, containing a very special plant discovered by and named after the founder of Tondoon's Herbarium, Norm Gibson. Its botanic name is *Oldenlandia gibsonii*. It is happily growing alongside plants such as *Senna acclinis*, *Alyxia ilicifolia* subsp. *magnifolia*, *Graptophyllum* sp., *Dansiea elliptica*, *Xylosma ovatum*, to name just a few, and *Alyxia sharpei*, those of you who do not know this one will soon find out if you run into it in the bush... (very sharp!).

On the right we pass the Rainforest Proteaceae, where at the right time of the year you can look up and see the magnificent Queensland Waratah, or *Oreocallis wickhamii* in flower. The bright red amongst the darker green leaves is just stunning. On now to the Daintree area, the vegetation is becoming more dense, and it is getting cooler and quite heavily shaded. The bright red fruit on the ground belongs to *Phaleria clerodendron* or Scented Daphne, the flowers which are produced on mature wood, are creamy white and beautifully perfumed. Pandanus and gingers grow alongside the footpath.



**Above:**  
Looking towards Kroombit Tops.

**Left:**  
Kroombit Tops on left of path

**Below:**  
Kroombit Tops  
See page 121    Photos: T Hanson



Let's follow the path to the left up into the Tablelands area. The trees are heavy with vines and creepers, with ferns on the forest floor, and tree ferns in the creek line. It is very peaceful, cool and humid. Just the sounds of the birds, the wind in the high canopy and the water running downwards. After crossing the creek via a wooden bridge, we climb up stone steps to the Bamaga area. The path climbs upwards to a shelter and across a high bridge, however we will take the path to the right, natural bush on the left hand side contrasts greatly with the lush green growth on the other side. There are paths leading in all directions through the gardens, so you really need to come for a few days to be able to see the whole picture, and discover all its wonders. This path we are taking crosses the creek again, with fan palms growing on its banks. A Brush Turkey has decided to join us, he has a great time scratching up the leaves and mulch for his dinner. Look at the brilliant deep pink of the new growth of *Waterhousea unipunctata*. It's stunning isn't it?

We will go back via the lower end of the Kroombit Tops section, across a pond over the stepping stones. (Photo opposite on page 120). Myriads of butterflies seem to love this area (mosquitoes too). Maybe the heavy planting of *Harpullia pendula* attracts them. A quick stroll brings us back to the courtyard, here you may see groups of school children as 5000 children a year visit with their schools or during the holidays for the Educational and school holidays programs run by Visitors Services Co-ordinator Marilyn Haigh and her volunteers. Most weekends, beautiful brides and their grooms can be seen with their guests as Tondoon is a favourite venue to hold ones wedding. Ecofest is an annual event, industry work in with the environment, huge tents house the EPA, Gladstone area Water board, etc, where information about their own area can be sort. There are guest speakers on different subjects such as composting, water wise gardening and propagating, and on going entertainment. Gladstones SGAP have a tent where local members grow indigenous natives in tubes to sell to the public at a very low price. Most of the plants we grow are not available in the local nurseries. The Rockhampton SGAP branch helped us this year with their bush tucker fruits and jams... very popular.

I have only just touched on Tondoon's wonders, we would LOVE to show you the real Tondoon. Please come and visit us in person, you would be very welcome. Guided tours occur each Tuesday or by special request. When you do come, I would like to warn you that our mosquitoes are also very friendly especially after rain, so be prepared.



**Top:** Male fruit of  
*Macrozamia platyrhachis*

**Centre:** Female fruit of  
*Macrozamia platyrhachis*

**Left:** *Livistona* sp.

**Opposite:** A fern garden in  
Blackdown Tableland

See page 123

Photos: Ann McHugh

# Blackdown Tableland

Part 2/2 \_\_\_\_\_ Ann McHugh, SGAP Rockhampton

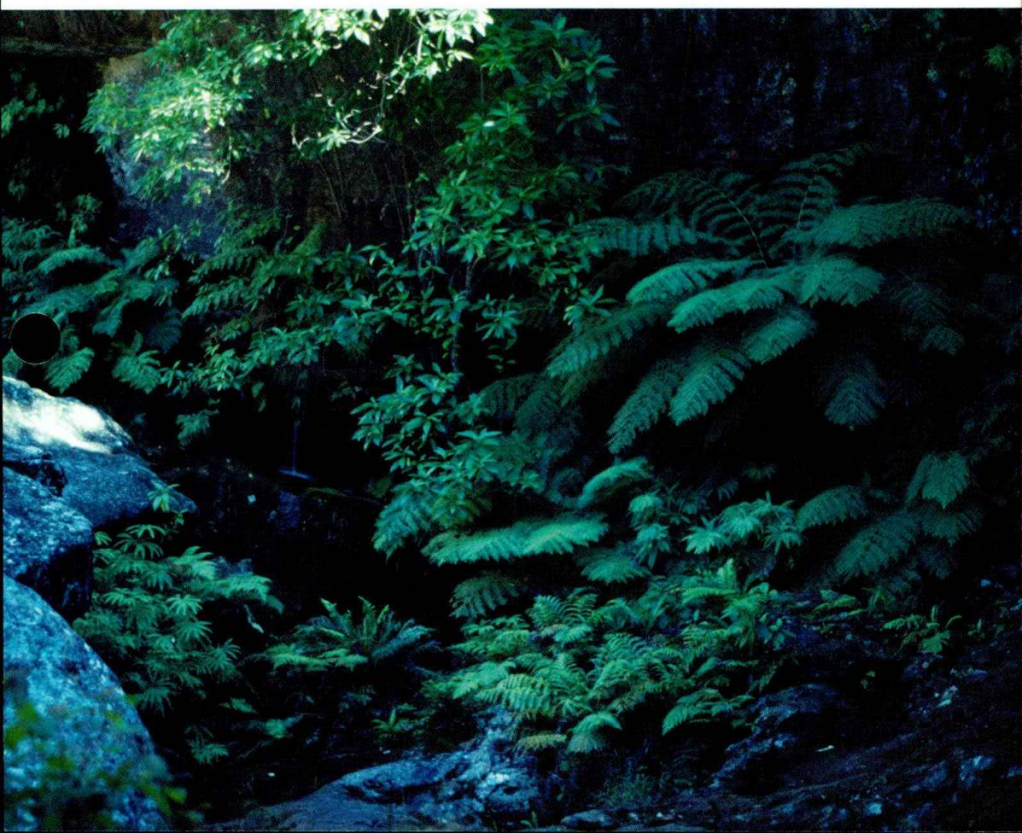
## Plants Endemic to Blackdown

There are well over 30 plant species endemic to Blackdown. Probably the most well known is *Eucalyptus sphaerocarpa* (the Blackdown Stringybark). This magnificent straight gum has been logged for many years, but is now protected, at least for the near future. Some of the trees recorded to have been taken out were immense and rivalled the south Queensland forest giants. The bark on this tree is distinctively fibrous and rough, as you will find if you brush past it.

*Macrozamia platyrhachis* is another curiosity on the Tableland. This *Zamia* is almost prostate with just a few fronds emerging from near the ground, and the male and female cones at ground level also. (Photo opposite on page 122).

The endemic *Livistona* grows in gorges on the southern sides. Driving up to the tableland in spring through the *livistonas* in full flower is a fine sight. They flower prolifically and are attended by hordes of bees (mostly European) and other insects. (Photo opposite on page 122).

There are at least 8 orchid species thought to be endemic but more work needs to be done on these. Some of these are tiny epiphytes.







**Flora of Blackdown Tableland**

**Opposite Top:**

*Petrophile canescens*  
(fruit shown on back cover)

**Opposite Centre:**

*Stenocarpus salignus*

**Opposite Bottom:**

*Banksia spinulosa*

**Above:** *Grevillea singuliflora*

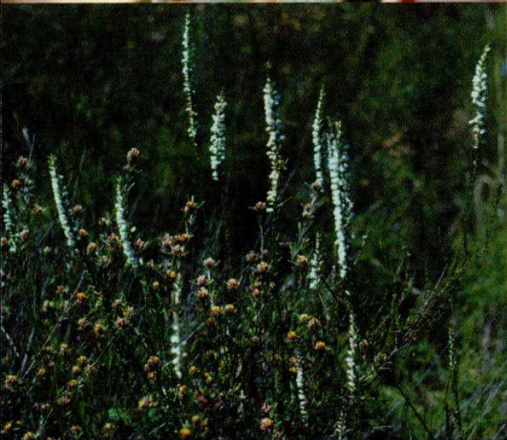
**Left:** *Lomatia silaifolia*

**Below:** *Grevillea longistyla*

See page 129

Photos: Ann McHugh





# Flora of Blackdown Tableland

## **Above:**

*Grevillea floribunda* ssp. *floribunda*

See page 129.

Photo: B J Plumb

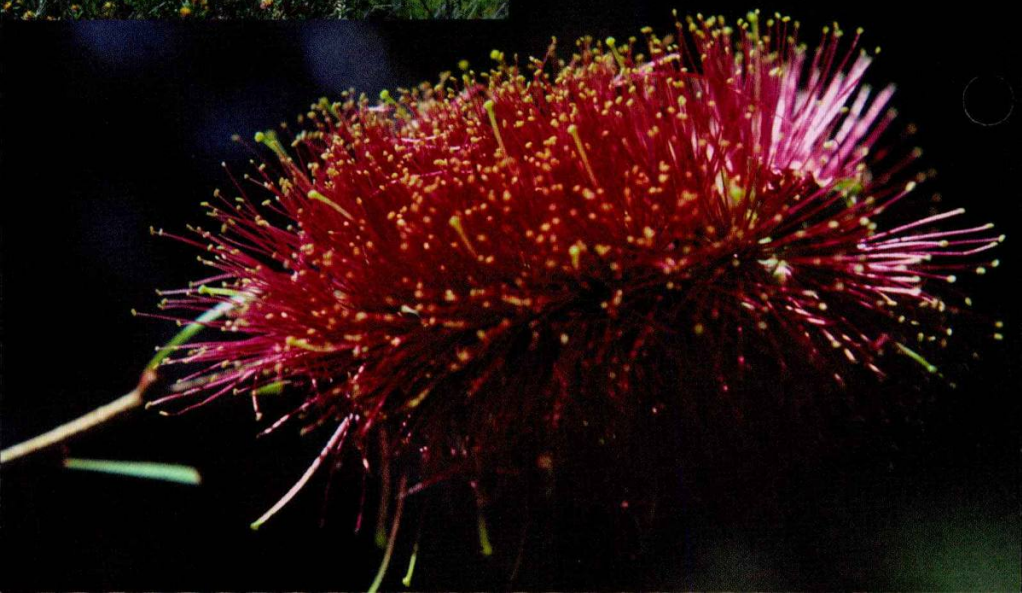
## **Left:**

*Epacris obtusifolia*

## **Below:**

*Callistemon pearsonii*

Photos: Ann McHugh





**Above:**

*Ricinocarpus* species unnamed

**Left:**

*Logania diffusa*

**Below:**

*Prostanthera* species  
undescribed

Photos: B J Plumb





Above:

*Diuris sulphurea*

Below:

*Stylidium graminifolium*

Photos: Ann McHugh



## Proteaceae In Blackdown

The Proteaceae family is well represented on Blackdown with 16 species over nine genera. Five Grevilleas, two Banksias, two Hakeas, two Persoonias, as well as *Conospermum taxifolium*, *Lomatia silaifolia*, *Petrophile canescens*, *Stenocarpus salignus* and *Xylomelum pyriforme*. (Photos on pages 124, 125 and back cover.)

The two Banksias flower mostly in late summer. *Banksia oblongifolia* and *B. spinulosa* var. *spinulosa* grow in many different areas of Blackdown, mostly on the rocky sandstone flats adjacent to the major creeks. These provide a summer food source for the many honey eating birds and animals, such as White-eared Honeyeaters; an isolated population of Yellow-tufted Honeyeaters; two species of gliders and Pygmy possums. Neither *Banksia* grows to great heights, but both flower prolifically. The Blackdown form of *B. spinulosa* in particular is a very fine example of this species. (Photos on page 124.) Of the five Grevilleas, *Grevillea longistyla* adds a splash of red to the golden wattles in the spring. (Photo on page 125.) *G. parallela* and *G. striata* occur mostly on the lower areas, being found throughout Central Queensland. Where *G. parallela* flowers in the spring, *G. striata* is somewhat unpredictable, sometimes not flowering at all. The other two are small shrubs. *Grevillea floribunda* is rather obscure and not often noticed with its dusty foliage and curious hairy rusty coloured flowers. (Photo on page 126.) *G. singuliflora* is a really pretty almost prostate plant. It grows along rocky creek banks and cascades over the rocky ledges. The round wavy leaves are light green with rose to copper new growth. The tiny single lemon-green flowers are hardly noticeable, but if this plant could be cultivated it would be an attractive addition to a rock garden. It is definitely one of my favourites.

Of the two Hakeas, *Hakea lorea* is found on the way in and in lower drier areas and *H. plurinervia*, a small shrub with rough grey leaves and fragrant white balls of flowers, is found in open rocky heathland areas on top of the Tableland. The leaves are almost always partially eaten by insects.

*Persoonia falcata*'s falcate leaves are often mistaken for a wattle. However the small yellow bunches of flowers and nutty fruits give a clue to its identity. *P. fastigiata* is an attractive small shrub with yellow flowers and edible fruits.

Of the other Proteaceae, *Stenocarpus salignus* grows widely in open woodland areas, often in thick coppices. It grows into a spindly tree to about 3 metres, with shiny dark green leaves and masses of fragrant white flower whorls. This would be an interesting specimen for a garden. (Photo on page 124.)

*Xylomelum pyriforme*, the woody pear, is a species of a genus found right across the top of Australia. The trees grow in open high areas of Blackdown, but are also common in other sandstone areas particularly Robinson Gorge. The greyish green leaves are spiky and toothed at first but smooth edged later. The flowers, which appear in April, are a small rather insignificant white spike. The large woody seed capsule is distinctive, about 4 or 5 cm long and pear shaped. These persist on the tree and open to reveal winged seeds.

*Petrophile canescens*, which flowers in the summer, is a curious plant with green many branched leaves and cone shaped white flower heads which turn into hard cone like seed heads, similar in appearance to a pine. This plant is found on the higher open rocky heath areas. (Photo on pages 124 and back cover.)

*Conospermum taxifolium* is a shrub growing to about 2 metres. It grows along creeks in wetter north-easterly areas. The shrub has upright branches with hard spiked green lanceolate leaves. The curious small white flowers have three prominent petals and when the flowers fall a fringed seed capsule is left.

*Lomatia silaifolia* grows as a shrub or small tree on open woodland slopes. The plant has very attractive divided foliage. The showy white flower heads, which grow on top of the shrub, appear in late spring to summer, and can be seen as late as January. The flowers are reported to be poisonous to stock. (Photo on page 125.)

### Flowering Season by Season

Winter into spring is probably the most spectacular time on the Tableland. The Wattles in Central Queensland start flowering in June and Blackdown's wattles put on a spectacular display right through from June to September. There are over 40 species of *Acacia* on Blackdown, including two endemic species: *Acacia storyi*, a beautiful feather leafed variety with large racemes of pale cream balls, and *A. gittinsii*, a medium sized shrub with fine phyllodes and masses of deep gold balls along the stems. These are later flowering, from July to August. (Photos in the June 2005 edition.)

The many acacias on Blackdown come in all the shapes and forms you can think of, from the small prickly species to the very showy forms like *Acacia macradenia*, which greets visitors on the way up the range in June-July.

Most of the other spring flowering plants complement the wattles. Some to mention are the white flowered Wedding Bush, *Ricinocarpus*, (photo pg. 127), olearias, and the many leucopogons and loganias, (photo pg. 127), mixed with pink boronias and zierias, the lovely red *Grevillea longistyla* and *Bossiaea carinalis* and the purple hoveas and hardenbergas. Others at this time are hibbertias, and the many yellow pea flowers like *Pultenaea*, *Phyllota*, and *Daviesia* species.

Another oddity to be seen in spring is the leafless orchid *Pseudovanillum cassythoides*. This orchid lives mostly underground in a symbiotic relationship with a particular fungus. In spring the leafless brown vine-like flower stalks grow and climb over anything handy and produce masses of cream and white orchid flowers. They are quite common and can be seen on many tree trunks and stumps. The two species of *Astrotricha*, the large leafed *A. pterocarpa* and the narrow leafed *A. longifolia* produce their large heads of flowers and fruits in spring also.

Coming from the often dry and dusty lowlands the spring flower show with its enormous variety is stunning.

Summer on Blackdown can also be rewarding flower wise. Many plants flower quickly after the summer storms. These include *Thysanotus*, and *Dampiera* species, the white *Lomatia*, many of the orchids - both terrestrial and epiphyte, dianellas and the beautiful banksias. In late summer, the *Schizaea bifida* (Forked Comb Fern) produces its distinctive comb like spore heads, in moist heath areas, and the rare *Burmannia disticha* shows its bright purple heads of bracts topped by the small yellow flowers. The curious brown and yellow flowers of the Queensland Blood Lily, *Haemodorum austroqueenslandicum*, our relative to the Kangaroo Paw, stand out above the grasses, followed by hard shiny seed capsules which were used by the locals in dried flower arrangements.

Late summer and autumn is often the time of the most rainfall on Blackdown. Many flowers thrive in this time, when the creeks and waterfalls are at their best. The ferns particularly, often washed by flooding creeks put out their new growth.

### Fauna

Of the fauna on the Tableland the most noticeable is the birds, with about 120 species being noted at various times. Of course the ubiquitous Pied Currawong is always present, and not to be fed under any circumstances. This beautiful bird, whose echoing 'coo-ee' like call is synonymous with mountain forests throughout Australia, has made itself a great nuisance by adapting rather too well to well-meaning but misguided campers encouraging them. Other birds commonly seen are Apostle Birds, White Winged Choughs, Tree Creepers and Variegated Wrens. Many beautiful honey-eaters, including Eastern Spinebills, Yellow-tufted and Yellow-faced Honey-eaters are frequently seen in the many flowers, and the tinkling notes of the thornbill families are ever present as you walk along the tracks. Peregrine Falcons are often seen at Peregrine Lookout.

Mammals are less noticeable. Greater gliders are numerous and easily seen at night when the eucalypts or angophoras are in blossom, but scarce when the large Powerful Owl is about. Wallabies can be seen occasionally on rocks near the road in, and some of the smaller rats and antechinus may be glimpsed at night.

Reptiles are scarce in the cooler months, but are common in spring and summer. The large lace monitors are quite tame and can be a nuisance around the camp sites as they will thief anything they can get hold of, particularly eggs and meat scraps. Jacky lizards and water skinks are often seen and geckos can be found at night with a torch. Frogs can be heard but are not often seen, and large blue-eyed eels are occasionally found in the water holes of Rainbow Creek. Of the insects - bees, flies, ants, and moths are the most noticeable. The rare and curious Blackdown monster 'Cooloola Dingo' is a rare sight.

## Impressions

Ted and I first started to visit Blackdown in the late 1970's. Gradually, over the years it has become for us a place to 'get away', where the rest of the world is a million miles away. While we were both working we spent as many weekends up there as we could. But when we retired we promised ourselves that we would not go up on weekends any more, but would go for a week at a time. It is always a good feeling to pack and get ready, with ideas of what we will see. The early morning drive to the park is quiet and refreshing, and the tableland is bright blue in the morning light. The road up is always rough and the famous pea gravel makes driving a cautious task.

We spend most of our time checking out the various walks, or chatting to the ranger on what is news in the park. Ted likes the big quiet water-holes whilst I like the small silent pools where the drosera and rushes grow, and the wrens and honey-eaters come down for a drink or a water skink pauses to admire its reflection or to watch for a stray tadpole snack. We love the many walks along the creeks, past tiny waterfalls and the peculiar 'bath holes'. It is always pleasant to stop to photograph the many flowers or tiny orchids. We often think of the first people to see these places and imagine what they thought of what they saw. How the Aborigines used their favourite herbs and medicinal plants or rested beside the quiet waters for a 'Goanna Barbecue'; how the first white men brought up their cattle to graze, and how they must have marvelled at the lovely sights to be seen and the quiet nights.

All too soon it is time to pack up camp and head home. On the way down we are already planning our next trip.

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### Other Information

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# Smoke and Mirrors in Kangaroo Paw Germination

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Poor germination or difficulty in securing reliable germination has been a deterrent to the introduction of many attractive native plants into hobby cultivation as well as the reintroduction of native flora in rehabilitation projects. Much of the problem can be ascribed to low seed viability and/or obstinate seed dormancy. The latter aspect has been a focus for research in recent years, particularly in relation to the role of environmental cues in breaking dormancy. Understanding the natural triggers can lead to efficacious seed treatments that emulate and yield the same inductive effect of environmental cues.

## Role of smoke in germination

The discovery of smoke as a germination trigger in South African fynbos species by Neville Brown<sup>1</sup> and colleagues in the early 1990's is a watershed. This has guided researchers<sup>2,3</sup> in WA to demonstrate a similar stimulatory effect of smoke, and seeds of some 70 heathland species from the Kwongan sandplains and the south-west of the State have now been shown to be smoke responsive. In the Chaparral of southern California, the germination of many scrubland species appears to be cued by gaseous emissions from charred wood left after a fire (Keeley<sup>4</sup>); recently Australian researchers (Jefferson & Pennacchio) working at the Chicago Botanic Garden demonstrated that some Prairie wildflowers and grasses germinate readily when exposed to smoke, whereas it had previously been assumed that their germination was cued by the end of winter dormancy<sup>5</sup>. A common denominator between these widely-separated geographical regions is proneness of their vegetation to fire and the importance of fire to their ecology, particularly in seedling recruitment, species composition, succession and, ultimately, shaping of the natural vegetation.

The composition of smoke is complex: some 71 different compounds have been identified in smoke extracts, including organic acids, phenols, aldehydes, ketones and a variety unrelated organic compounds (Baldwin *et al.*<sup>6</sup>). Interestingly, none of these compounds in pure form or in combinations were able to reproduce the biological effect of smoke, although a specific constituent of smoke was recently identified by researchers at the University of WA as the probable 'magic bullet' of smoke-cued germination (Flematti *et al.*<sup>7</sup>). In its pure form, this compound - a butenolide or more precisely 3-methyl-2H-furo [2,3-c]puran-2-one, nomenclaturally speaking in arcane Organic Chemistry - was shown to replicate the stimulatory effect of smoke water in tests with 'Grand Rapids' lettuce, *Conostylis aculeata* and *Stylidium affine*.

However, it is doubtful that the stimulatory effect of this 'magic' smoke compound is universal across all putative fire-responsive native species. For instance, there is now evidence that germination in kangaroo paws, especially the common red-and-green or Mangles' Kangaroo Paw (*Anigozanthos manglesii*), respond unequivocally to heat rather than to smoke - see below for experimental details and discussion. In the context of a kangaroo paw breeding program (e.g. *Australian Plants* March 1998, March 2000) early and reliable germination of freshly-harvested hybrid seeds each year is imperative if an uninterrupted turnover of plant generation is to be achieved. Until recently, fresh seeds have to be stored for at least a couple of years to alleviate dormancy.

Although smoke and smoke water have proved most effective in cueing germination in a range of scrub- and heath-land native species, they appear ineffectual on dormant seeds of Mangle's Kangaroo Paw, in sharp contrast to prolific germination achievable with heat shock (Table 1, Fig. 6). One could reasonably deduce from this empirical experience that the effect of bush fire in the natural setting can be ascribed more to heat than to smoke. Older seeds do however show a very modest response to smoke but not to the same extent as heat pulsing. This casts doubt on whether the two different germination cues - smoke and heat - share a common dormancy-breaking mechanism. Smoke is postulated to act physiologically by inactivating (altering?) the chemical inhibitors of germination located in seed tissues<sup>3</sup>. Heat, on the other hand, probably acts by destroying inhibitory compounds(s).

The nature and where these germination inhibitor(s) reside have yet to be elucidated. The former is clearly in the realm of analytical chemistry when putative compound(s) are isolated and their biological activity demonstrated. Clues to the latter aspect are more tempting. The microscopic embryo (80  $\mu$ m) in the seed is located superficially within a tight vestibular chamber just beneath the seed apex. Naked embryos extracted from dormant seeds will germinate precociously and rapidly *in vitro* on agar medium (Fig. 9) indicating instant relief from the inhibitory influence of its protective tissues. The pigmented seed coat and related extraneous tissues are plausible candidates as sources of germination inhibitors partly on account of tissue contiguity and their chemical complexity.

### Seed structure

In its dry state, the seed is wrinkled and roughly pyramid-shaped albeit with a triangular base (Fig. 1). The seed is grooved from the seed base to the apex and the surface is finely textured with parallel striations running across the grooves and ridges. The seed coat proper is strongly pigmented (black) and 'shrink-wrapped' with a thin fabric of white cellulose fibres impregnated with tiny shiny crystals of unknown chemical nature (Fig. 3). These crystalline specks are not dissolved by water or organic solvents, although the seed coat can be 'de-pigmented' with an alkali (Fig. 4). Short breaks and tears in the fibre mat impart a superficial appearance of pitted grooves and ridges on the seed.

**Table 1. Germination response after seed treatment:**

| Seed age<br>(years) | Treatment                           | Germination (%)<br>mean $\pm$ 1.96 SE (n)                      | Comment                          |
|---------------------|-------------------------------------|----------------------------------------------------------------|----------------------------------|
| 0.5                 | nil (control 1)                     | 5.5 + 3.2 (200)                                                | staggered over 10 weeks          |
| 1.5                 | nil (control 2)<br>→ heat (80°C/2h) | 7.0 $\pm$ 3.7 (185)<br><b>77.6 <math>\pm</math> 7.1</b> (132)  | from weeks 2–3                   |
| 3.5                 | nil (control 3)                     | 16.9 $\pm$ 5.8 (160)                                           | - ditto -                        |
| 0.5                 | Smoke water<br>(10%/24h)            | 14.0 $\pm$ 4.8                                                 | - ditto -                        |
| 1.5                 | Smoke water<br>(10%/24h)            | 15.0 $\pm$ 4.9 (200)                                           | - ditto -                        |
| 3.5                 | Smoke water<br>(10%/24h)            | 8.5 $\pm$ 3.9 (200)                                            | rapid, days 8–14,<br>max day 8   |
| 0.5                 | heat (80°C/2h)                      | <b>94.0 + 3.3</b> (200)                                        | - ditto -                        |
| 1.5                 | heat (80°C/2h)                      | <b>89.1 + 6.1</b> (101)                                        | - ditto -                        |
| 3.5                 | heat (80°C/2h)                      | <b>92.2 + 3.9</b> (180)                                        | - ditto -                        |
| 1.5                 | KOH (01N/1h)                        | 46.7 $\pm$ 4.7 (430)                                           | seed coat pigment<br>leached     |
| 1.5                 | HCl (01N/1h)                        | 2.6 $\pm$ 2.3 (165)                                            | no colour change<br>in seed coat |
| 1.5                 | EDTA (1mM/1h)<br>→ heat (80°C/2h)   | 7.2 $\pm$ 3.5 (270)<br><b>31.9 <math>\pm</math> 6.3</b> (210)  | metal chelating<br>agent         |
| 1.5                 | xylene<br>→ heat (80°C/2h)          | 2.3 $\pm$ 2.6 (129 )<br><b>20.2 <math>\pm</math> 7.1</b> (124) | organic solvent                  |
| 1.5                 | leaching<br>(tap water, 10d)        | 8.6 $\pm$ 4.6 (140)                                            | no colour change<br>in seed coat |

SE = standard error; n = number of seeds in test sample

**Is dormancy due to lack of enzyme activation?**

Another perspective towards understanding seed dormancy in Kangaroo Paws considers activation and the role of seed enzymes in marshalling seed reserves towards the germination process. Seed viability can be gauged by staining extracted embryos with the chemical 2,3,5-triphenyl-tetrazolium chloride, which acts as an artificial electron carrier by accepting electrons and protons stripped from metabolised sugar intermediates by a group of enzymes (dehydrogenases). In the cell this role is played by membrane-bound electron carriers (cytochrome c) in mitochondria - the cell's mini power generators – which harness cascading energy which would otherwise be lost. The energy is captured in energy-rich phosphate bonds in adenosine triphosphate molecules (ATP), the cell's universal energy currency, which is expended to drive all growth and developmental processes including germination.

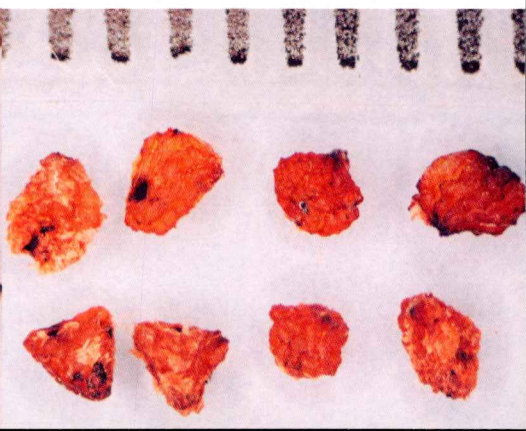
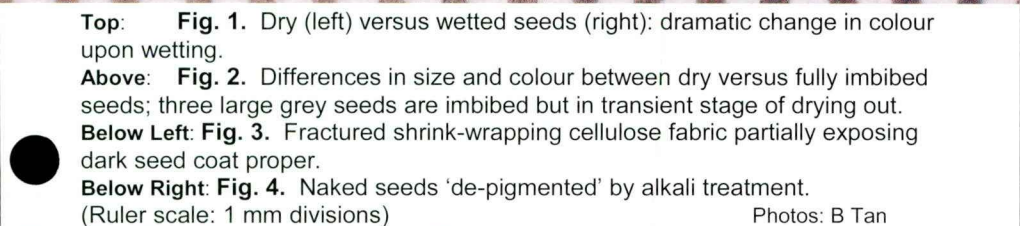
Depending on respiration rate, viable seeds will possess varying levels of dehydrogenase activity. Respiring seed tissues will convert the colourless tetrazolium molecule by 'redox' chemical reaction into an insoluble red dye (formazan). Accordingly, actively respiring tissues will stain strongly (red) while non-respiring (dead) ones will not stain at all (opaque white) and pink-staining tissues reflect a low to modest respiration rate. (Fig. 5)

Whilst red and pink staining reaction is indicative of viability and a potential to germinate, there is no direct relationship between the proportion of stained embryos and resulting germination in tests. With fresh seeds, germination is significantly lower than that indicated by the tetrazolium viability test, suggesting constraints other than dehydrogenase activity which, speculatively speaking, may involve other important enzymes or chemical inhibitors which have not been overcome. Significantly, embryos from heat shocked seeds stain strongly compared with those from non-treated and smoked seeds (Fig. 5).

### **Breaking dormancy**

Germination involves initiated biochemical and physiological processes within the seed culminating in emergence of the germinal root. Whilst water and oxygen are requisites for germination, constraint(s) imposing dormancy have to be overcome to initiate these processes. In the case of the Kangaroo Paw seed, this is likely to be chemical in nature as there is no evidence of an impervious seed coat: an imbibed seed swells to 3–5 times of its original size within minutes (Fig. 2).

The data comparing germination response after a specific physical or chemical seed treatment (Table 1) unequivocally demonstrates heat shock as a very effective dormancy breaker in comparison with smoke water and other treatments. Following heat shock germination is generally in excess of 90%. The role of potash (KOH) – a product of ash after a fire – is also worthy of further investigation. Although germination was staggered over four weeks in this alkaline seed treatment, compared with two weeks in most treatments, final germination was 47%, compared with values of generally <10% for most non-heat treatments. Dilute hydrochloric acid treatment was ineffectual, as was with a powerful chelating agent (EDTA) or a strong volatile organic solvent (xylene). These latter seed treatments were applied on the premise that chemical inhibitors of germination may be present in/on external tissues and can be removed by one of these potent solvents or agents. In light of higher-than-expected germination with potash, a second comparative experiment was undertaken to confirm its ameliorative effect. After an hour of soaking in a mid-strength (0.1M KOH solution, a significant amount of seed coat pigment (dark brown) was leached with complete pigment removal if seeds were soaked overnight (Fig. 4). The alkaline treatment was followed by ten consecutive days of washing under a tap to remove all traces of potash before plating out for germination (reason: residual traces may have been the cause of staggered germination in the initial experiment). The control treatment was leaching with water under a tap for a similar extended period. Seeds thus treated displayed a significantly higher germination ( $19.3 \pm 3.3\%$ ) after 3 weeks compared with the water-leached control ( $8.6 \pm 2.4\%$ ).



**Top: Fig. 1.** Dry (left) versus wetted seeds (right): dramatic change in colour upon wetting.

**Above: Fig. 2.** Differences in size and colour between dry versus fully imbibed seeds; three large grey seeds are imbibed but in transient stage of drying out.

**Below Left: Fig. 3.** Fractured shrink-wrapping cellulose fabric partially exposing dark seed coat proper.

**Below Right: Fig. 4.** Naked seeds 'de-pigmented' by alkali treatment.  
(Ruler scale: 1 mm divisions)

Photos: B Tan

Germination in a separate quasi-control group without water leaching was  $9.5 \pm 2.1\%$ . No completely 'de-pigmented' seed germinated, and there was evidence of endosperm tissue damage from alkaline hydrolysis. This experiment suggests that if a germination inhibitor(s) is present in/on the seed coat, it is not water soluble but modestly so in an alkaline solution.

An alternative and equally plausible explanation for the modest potash effect is improvement of cell membrane permeability and activation of certain important seed enzymes (e.g. alkaline phosphatases?) in an alkaline cellular environment. Although final germination was only about 20% there is obviously scope for refinement of the potash application protocol, specifically in optimisation of treatment span and potash concentration with avoidance of hydrolytic damage.

Biochemical staining tests indicated that the seeds used in the germination experiments were highly viable (>95% for fresh and 85–90% for older seeds). Considering the low germination percentages in the non-heat treatments notwithstanding excellent seed viability, it was reasoned that non-germinated but viable seeds can be induced to germinate if retreated with a heat shock. In this context, non-germinated seeds were recovered from a control and two non-heat treatments, air-dried over 2 days and then baked at 80°C for 2 hours before re-plating. A marked response (77% germination) was elicited in previously unresponsive control seeds (Fig. 8) while the response of seeds previously treated with EDTA (32%) and xylene (20%) was more modest but significant. A large proportion of embryos extracted from non-germinated seeds stained with tetrazolium indicating viability. A reasonable explanation for their failure to germinate despite the heat shock is their sliding into 'secondary dormancy', a condition of physiological stupor known to be induced by temperature extremes, prolonged darkness or light, water stress, excessive oxygen or too little oxygen. The efficacy of heat has nonetheless been re-affirmed by this follow-up experiment.

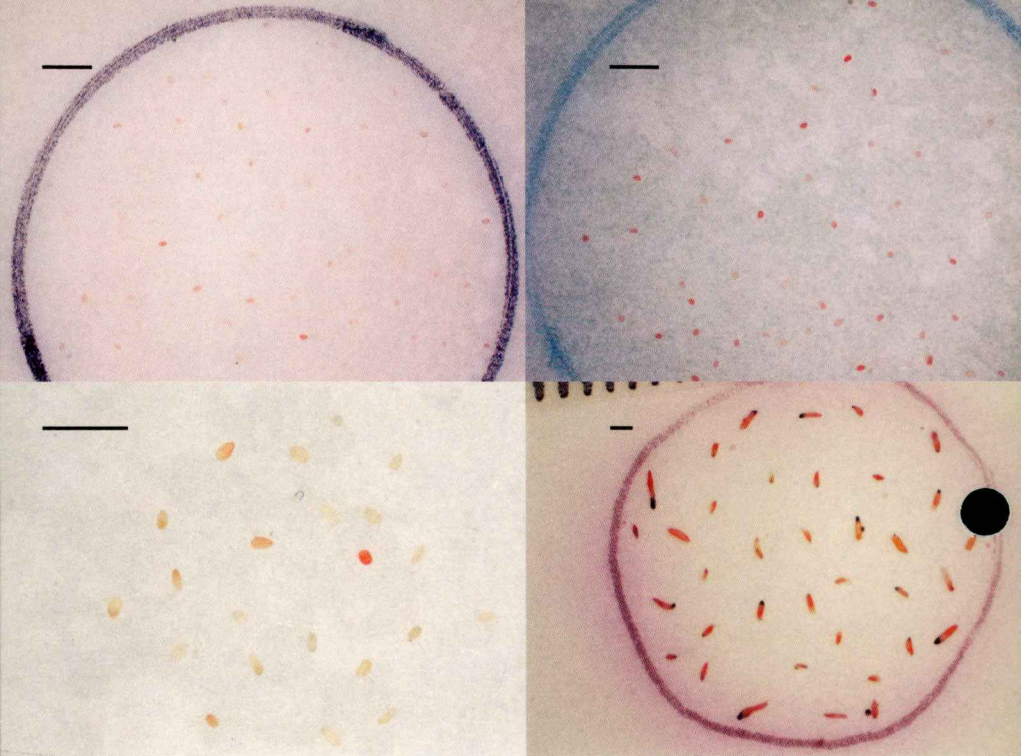
Heat shock as a seed treatment for breaking dormancy is effective over an impressive temperature range, from 70°C–120°C with lethality evident only above 125°C. Treatment can be as brief as a few minutes at the higher temperatures. Imbibed (wet) seeds, on the other hand, are killed at temperatures above 70°C (Fig. 7): it is interpreted that enzymes in desiccated seed tissues unfold upon re-hydration and are destroyed structurally at >65°C from breakage of their hydrogen bonds. Imbibed seeds exposed for 2 hours at 60°C showed moderate but staggered germination (43%) indicating some impairment but not total destruction of the biochemical processes in the seed at this incipient protein-denaturing temperature. [Note: this is the threshold temperature above which albumin protein e.g. egg white is denatured from coagulation] For comparison, dry seeds heated at 60°C yielded only 8% germination, meaning, 60°C is not hot enough to destroy germination inhibitors. The seed's potential to germinate is also not impaired by repeated wetting-and-drying cycles at normal ambient temperatures. All considered, the kangaroo paw seed, in its dry state, is capable of withstanding elevated temperatures that would normally be lethal to your average garden seed. This resilient property makes the seed admirably adapted to withstand the effects of periodic bush fire.

## Conclusion

There is no 'smoke and mirrors' for successful germination of dormant kangaroo paw seeds - the efficacious effect of heat shock is unequivocal. There is however a dull mirror left hanging on the wall but with some 'spit and polish' (i.e. further research) an image of the inductive potash effect will be reflected and perhaps, in the process, another mechanism for dormancy relief may be illuminated.

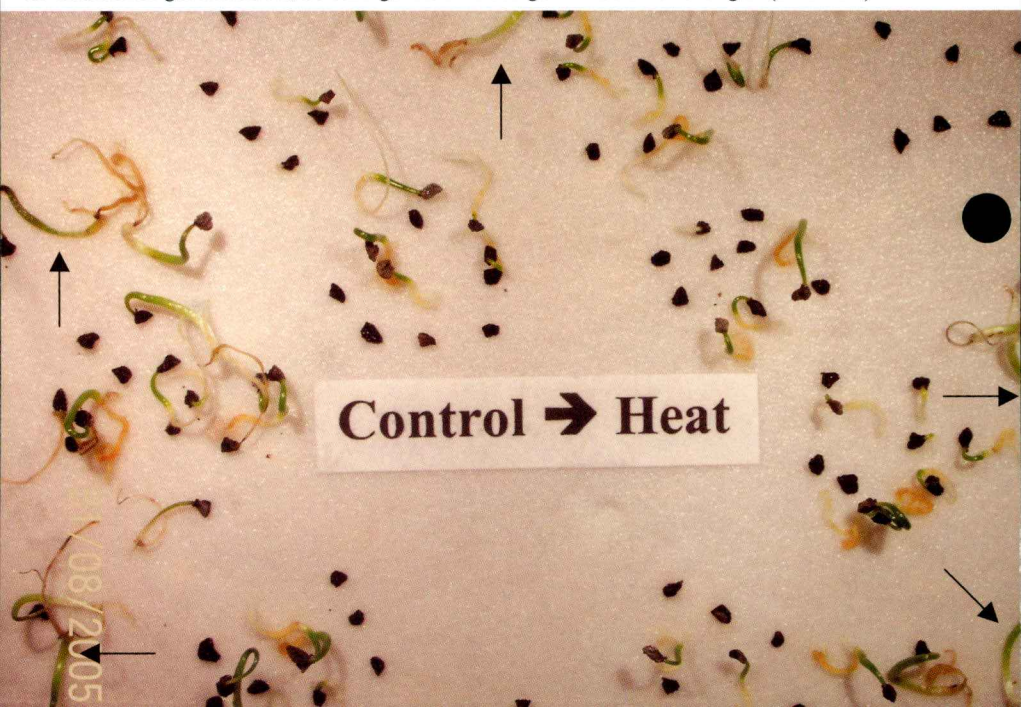
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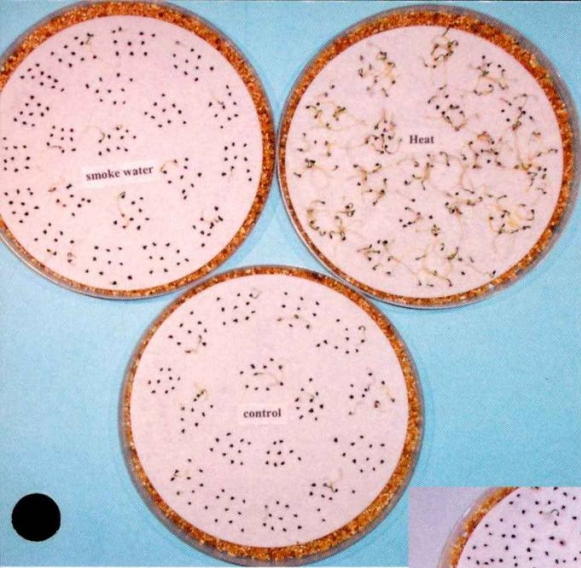


**Above: Fig. 5.** Tetrazolium staining reactions of extracted embryos from: (top left) control non-treated seeds and (bottom left) close-up; (top right) heat-shocked seeds; (bottom right) germinating seeds. (bar = 1 mm)

**Below: Fig. 8.** A follow-up heat shock treatment of non-germinated control seeds has resulted in additional germination; seedlings from initial germination are larger (arrowed).



Control → Heat



**Left: Fig. 6.** Comparison of germination response following heat shock (80°C/2h), smoke water (10%/24h) or no pre-treatment (control): the efficacy of heat shock is unequivocal.

Photos: B Tan

**Right: Fig. 7.** Germination 4 weeks after pre-treatment: clockwise - (top left) dry control; pre-imbibed, room temperature; pre-imbibed followed by heat shock (80°C/2h); dry, heat shock.



**Below: Fig. 9.** *In vitro* embryo culture: extracted seed embryos will germinate precociously and develop rapidly.

Photos: B Tan



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**Editorial Material:** Editor, Australian Plants, PO Box 744, Blacktown NSW 2148

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