

Australian Plants

Registered by Australia Post
Publication No. PP226253/00017

March, 1999
Vol. 20, No. 158

\$3.60



Growing better plants

We would all like to grow plants that are hardy in cultivation and rewarding with flowers and pleasing foliage. Occasionally, one particular plant in the wild is far superior to those around it. Hopefully, an experienced propagator will reproduce from this plant using cuttings, hopefully it will not be ravaged by commercial bush pickers, hopefully it will survive and not be a casualty of land development or degradation. Market it the plant requires a distinctive name, a cultivar name. The propagator is encouraged to do this through the Australian Cultivar Registration Authority, a process that is very inexpensive, in fact free to society members. This procedure only protects the cultivar name for a unique plant of distinction which may provide prestige and financial return for the propagator who goes to this trouble. It does not prevent anyone else from also propagating and marketing this exceptional plant under another name.

An alternative is registration of the plant under Plant Breeders Rights (PBR) as mentioned opposite. This confers exclusive rights for marketing. It provides a financial return for the effort in research and development, in this case Adelaide University. There are those who are suspicious of the PBR process. Anyone can develop exceptional forms as has been done here, the bush is an incredible resource. These plants have been developed for the cut flower trade to give assurance of quality and market season spread so desperately needed. It is hoped to curtail the bushpicking practice that is forcing this beautiful plant to extinction, not by "big brother" sanctions that are not being enforced but by producing a better quality product, more reliably harvested, packed and marketed.

CONTENTS

New <i>Banksia</i> released	Margaret Sedgley	43
<i>Banksia</i> research reports	Mary Rieger and Margaret Sedgley	47
<i>Banksia</i> as a cut-flower and for general horticulture	Margaret Sedgley	48
Edible wattle seeds of southern Australia	Bruce Maslin	56
Legumes of Australia, Introduction	J. H. Ross	59
Mimosaceae in Australia	J. H. Ross, Garry Sankowsky and W. H. Payne	62
<i>Eucalyptus cinerea</i> , lignotuber studies	A. Graham, M. Wallwork, M. Sedgley	77
Ornamental eucalypts, its commercial prospects	W. H. Payne and K. Delapointe	83
Diseases of flannel flower, Sturt's desert pea, and everlastings	Brett Sommerell	84

COVER PLATE, A unique flower arrangement featuring *Banksia* created by Nola Parry. Nola leads a small band of workers who, each year, produce a stunning display of wildflowers all artistically arranged, at a floral spectacular near Gosford, NSW. Last year the centre piece was an old fashioned small merry-go-round and each of the seats had an arrangement such as this. Page 48 shows one of the surrounding display shelves, in this section, also featuring *Banksia*. The Parrys wildflower nursery at Kariong has been the place to go for me over the last 50 years for well prepared plants. Nola is Secretary of the Australian Native Flower Growers and Promoters, an association of commercial cut flower growers she helped the society to create to promote the plantation cultivation of wildflowers and their promotion as cut flowers and to discourage the ravages of bush picking.

AUSTRALIAN PLANTS No. 158 issue of Volume 20, comprising issues 157-164. International Series Index ISSN 0005-0008. A national publication in 9,000 copies. Published by The Australian Plants Society, registered as Society For Growing Australian Plants, NSW Ltd., A.C.N. 002 680 408.

Publication date of previous issue No. 157 was 30th November, 1998.

New *Banksia* released

from Professor Margaret Sedgley,
The University of Adelaide, SA.

Three new *Banksia* varieties have been produced from the selection program. The three varieties were selected for commercial cut flower production, but all make excellent garden specimens. They are vigorous, produce many blooms, and are very attractive to birds. Selection for commercial purposes has resulted in an extended peak flowering period from February to August, a greater abundance of long flowering stems and an attractive flower colour. A further advantage hoped for is greater ease and more reliability in cultivation. Continued selection and breeding would extend these features, an even longer flower production period, improved colour in the flower heads and reliable performance in cultivation.

All three varieties bear the name 'Waite' in memory of Peter Waite, the distinguished pastoralist and businessman who endowed the University of Adelaide to establish agricultural research and teaching activities. Rooted cuttings of the three varieties are now available from Proteaflora Nurseries Pty. Ltd. Phone 03 9756 7233 to place your order.

***Banksia* 'Waite Orange'** (Figure 1) is a natural interspecific hybrid between *Banksia hookeriana* and *Banksia prionotes*.

It is intermediate between the two in flowering time, with a peak mid year, and along with the parental species, provides year round production reliability of orange *Banksia* blooms. Its attractive leaves are intermediate between the fine foliage of *B. hookeriana* and the coarser leaves of *B. prionotes*, setting off the medium to large orange and buff blooms. The plant is vigorous and produces abundant inflorescences on long straight stems. *Australian Plants*, volume 18, page 353 has large colour photographs of this cultivar together with the two parents.

Grower's tip:
Cultivars are
bred for reliability
in cultivation
and quality

***Banksia* 'Waite Crimson'** (Figure 2) is a mid-season high yielding selection of *Banksia coccinea* with wine red blooms. Peak flowering time in South Australia is September. The wild species has yielded considerable input to the Australian economy over many years. Because of this random harvest the quality of the blooms has been variable and does not assist reliable marketing. Commercial growers have been quick to plant a plantation and one of these is shown in colour in *Australian Plants*, volume 18, page 353.

***Banksia* 'Waite Flame'** (Figure 3) is a very early orange variety of *Banksia coccinea*, with peak flowering in South Australia in June/July. A reference to the photographs on the next page where the two cultivars are shown together does not do justice to the difference in colour of the fresh flowers but the real dividend is from the difference in the flowering/harvesting time extending the market.

Better wildflowers for horticulture! The above is an unprecedented announcement to support a private company for their profit. I do this as we need more ventures such as this. Not only will we all benefit from the enhancement of our gardens and landscapes with attractive plants but Australia will benefit from the export income it will generate. Our sincere thanks go to Professor Margaret Sedgley and her support team for a job well done. Editor.

Banksia 'Waite Orange', figure 1



Banksia 'Waite Crimson', figure 2



Banksia 'Waite Flame', figure 3





Photography by



Peter Abel and Burnie Kocur

What makes *Banksia* flower?

Report on recent research*

Research by Mary Rieger, the second Playford Memorial Trust Scholar in Ornamental Horticulture, has improved our understanding of what makes banksias flower. Field studies by Alison Fuss, the first Playford Scholar, had shown that *Banksia coccinea* and *Banksia menziesii* both initiate their inflorescences in late spring. Mary's work confirmed these results for *Banksia coccinea* using controlled environment cabinets. In these cabinets, we can control all of the environmental conditions to which the plants are subjected, including day temperature, night temperature, hours of daylight and light intensity. Flowering of *Banksia coccinea* plants was affected by the hours of daylight, with long days stimulating flowering, but not short days. The situation was different, however, for *Banksia hookeriana*. This species was more sensitive to temperature than to daylength, with flowering stimulated at high temperatures, but not at low temperatures. It is likely that these controls reflect the climatic environments of the two species, with *Banksia hookeriana* the more northerly of the two, and thus adapted to warmer conditions.

Relatedness of *Banksia* species

How related are different species of *Banksia*? In some cases, such as *Banksia hookeriana* and *Banksia prionotes*, the species are similar in appearance and it is likely that they are related to each other. This is confirmed by taxonomic study, which places them in the same group within the species. In other cases, such as *Banksia coccinea*, it is less obvious where affinities may lie. Tina Maguire has investigated the question of the relationships of *Banksia coccinea* using a range of different methods. She has crossed *Banksia coccinea* to a range of other species, and she has also investigated its genetic material in comparison to that of other banksias. *Banksia coccinea* is unique, it has no close relatives.

These genetic analysis methods can also instruct us on character differences within a species. Some variation is obvious, such as bloom colour and plant size differences in *Banksia menziesii*. Tina Maguire and Mary Rieger have investigated a number of banksias from this point of view, as this will assist us in the selection of more new cultivars. The results show that *Banksia* species are indeed very variable. However, some populations of the more endangered species, such as *Banksia coccinea* and *Banksia cuneata*, show very little genetic variability. This sounds warning bells, as low variability populations in a species which normally shows big differences means that some plant communities are too small to be sustainable in the long term. The information has important implications for conservation as well as for selection of new cultivars.

Propagation

We now have good cutting propagation methods for the Waite cultivars, but the cuttings have to be large for optimum success. For this reason we have studied tissue culture as an alternative. Kim Tynan studied this, and Eileen Scott was co-supervisor of the work. Kim achieved successful establishment, multiplication and rooting of plantlets in culture, but was not able to harden them off so they could exist outside the culture tube. More work is needed to perfect this.

***Acknowledgements:** This research was supported by the Rural Industries Research and Development Corporation, the Playford Memorial Trust, the International Protea Association, the Australian Society for Growing Australian Plants, NSW Branch and the Horticultural Research and Development Corporation. Sincere thanks to Alex George for taxonomic advice.

***Banksia* as a new cut flower crop* and for general horticulture**

The *Banksia* genus includes 76 species. The most widely cultivated for floriculture are characterized by terminal flowering of large showy inflorescences. These include the scarlet *Banksia coccinea*, the pink *Banksia menziesii*, the green/yellow *B. baxteri*, and *B. speciosa*, and the orange species *B. ashbyi*, *B. prionotes*, *B. hookeriana*, *B. burdettii*, and *B. victoriae*. *B. ashbyi* is mainly cultivated in Israel, whereas the others are grown in most *Banksia* production areas. Others cultivated to a lesser extent for cut flowers or foliage include the yellow-flowered species *B. grandis*, *B. sceptum*, and *B. integrifolia*, the brown *B. solandri* and *B. brownii*, and the orange *B. ericifolia*. Many other species of *Banksia* produce axillary blooms that are obscured by foliage and have short stems, but some terminal flowering forms of otherwise axillary-bearing species, such as the red *B. occidentalis*, have been used for cut flower production.

The most important commercial species is *B. coccinea*, and this is also the most problematic taxonomically. It has a number of unique features, and no obvious close relatives in the genus. It is important to know the taxonomic affinities of the major commercial species, so that attempts at interspecific hybridization can be directed toward the most closely related and hence productive crosses.

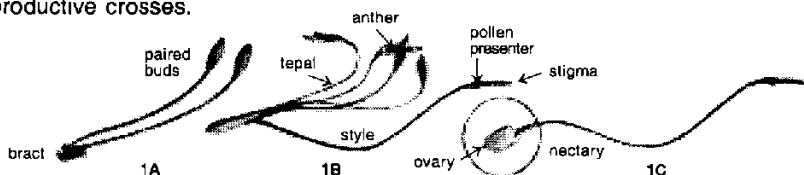


Figure 1. A, a pair of flower buds emerge from a central axis.

B, the style extends and the perianth tube (floral envelope) splits into four segments or tepals (petals) each with a pollen-bearing anther at the apex.

C, the exposed style terminates in a pollen presenter and stigma with an ovary and four small nectary glands at the base. Only a few flowers are fertilized to form woody follicles containing seeds.

A. Reproductive Structure

Banksia species range from prostrate forms to trees, and all are evergreen woody perennials, some of which regenerate from lignotubers following fire. Many flowers are crowded into showy inflorescences, which are followed by infructescences, often called cones, in which relatively few seeds develop in large woody follicles. The most common flower colours are yellow, orange, green, brown, and red. *Banksia violacea* produces purple flowers, and although the blooms are too small and obscured by foliage to be used in floriculture, it may provide a useful character for plant breeding. Foliage may be fine and needle-like or coarsely serrated. *Banksia* floral structure conforms to the typical proteaceous pattern of large numbers of individual flowers grouped together to form conspicuous inflorescences. In *B. coccinea* and *B. menziesii*, the flowers are produced spirally on the inflorescence, with 13 separate genetic spirals initiating simultaneously. The flowers develop in pairs, with each flower subtended by a floral bract and the pair of florets and their floral bracts subtended by a common bract. These bracts are inconspicuous, and the floral display is provided by the coloured perianths and styles.

*This is a review of work conducted by many researchers in Australia and overseas. It was published by John Wiley and Sons Inc., New York, in *Horticultural Reviews*, Volume 22, Edited by Jules Janick, ISBN 0-471-25444-4.



A wildflower display
(see page 42).
Photo by P. Abel



Banksia coccinea with
Eucalyptus foliage.
Photo by Bernie Kocur

A floral tribute or
corsage.
Photo by P. Abel



The *Banksia* flower has four tepals (petals/sepals, see the sketch on page 47 to make sense of what follows). The stamen has a single bilobed anther attached by a short filament to the distal region of the perianth (floral envelope). The pistil consists of an ovary with two ovules, and a long style with a small pollen-receptive stigmatic area in the apical region. In some species, the style elongates more quickly than the perianth during floral development, and arches beyond the corolla tube by protruding between two perianth members. An unusual feature of the genus is that the *Banksia* floral display is contributed entirely by the perianth and the style. In *Banksia coccinea*, for example, the inflorescence is grey prior to anthesis from the grey colour of the perianths, and red flowing anthesis from the red colour of the styles.

The distal portion of the *Banksia* style is specialized for pollen presentation, and its structure varies between species. The receptive stigmatic cells are located in a groove toward the tip of the pollen presenter, which in most species is located longitudinally and obliquely terminal, although in a few it is transverse or lateral. In *Banksia menziesii*, the pollen presenter has a complex internal structure, as observed by light microscopy, with the transmitting tissue enclosed by transfer cells, which may serve to maximize water and nutrient supply to the growing pollen tubes. The transfer cells are not present in the rest of the style, and the number of transmitting tissue cells declines over the approximately 2 cm length of the style, with only 11 cells present at the junction with the ovary. The *Banksia* style is a robust wiry structure with lignified sclerenchyma tissue located in the outer cortex. After flowering, the inflorescence develops into a woody infructescence, and successfully fertilized ovaries develop into follicles, each with one or two seeds. In most species the infructescence does not increase in size after flowering, and the mature follicles are much larger than the ovaries at anthesis, resulting in spatial limitations to fertility. An exception is *B. grandis* in which the axis, common bracts, and floral bracts enlarge around the follicles and become lignified, such that the mature infructescence can be used for cutting and turning into craft objects. Most species do not release their seeds until after fire.

Grower's Tip:
To release seed
from old cones
they need heat
in a fire or
oven

B. Breeding Biology

As in other proteaceae, the flower of *Banksia* exhibits protandry, with the anthers dehiscing prior to flower opening to deposit their pollen on the pollen presenter. This usually occurs one day before the flower opens, and following anthesis the pollen is collected by foraging fauna. At this stage the stigma papilla cells are not receptive to pollen, and peak stigma receptivity is attained three days after flower opening. This has been determined by an increase in the width of the stigmatic groove and by increase in pollen germination on the stigma in *Banksia menziesii* and in *B. coccinea* in stigmatic secretion. In the natural habitat all of the flower's own pollen has been removed by insect, bird, or mammal pollinators by the time the stigma is receptive, and the flower may be cross pollinated by a foraging animal that has visited another plant.

Outcrossing is a feature of the genus, and most species of *Banksia* that have been studied produce less seed following self pollination than following cross pollination. The self incompatibility is only partial, however, as controlled hand pollination of *Banksia menziesii* resulted in 80% infructescence set following crossing compared with 33% following selfing, and 6 follicles per crossed inflorescence compared with 1.3 after selfing. In *B. coccinea* all pollinated inflorescences set some seed, but the crossed infructescences had 40.7 seeds compared with 27.9 after selfing.

Further information was obtained from a 5 by 5 diallel experiment, with the results measured by pollen tube growth, observed using fluorescence microscopy. Pollen tubes had reached the base of the style by six days after pollination, but self pollination generally resulted in poorer tube growth. Statistical analysis showed that some plants were more successful parents than others, and that some crosses were more fertile when conducted in one direction than in the other. These results indicate that *Banksia* has a mixed mating system with complex genetic interactions. Most species are characterized by relatively low seed yields, attributed to a wide range of possible causes, including breeding system constraints, pollinator limitation, insect and bird predation, and poor nutrition.

C. Cultivars

Banksia species are relatively new to the cut flower industry, and there has been little emphasis placed on cultivar development. There are seven named cultivars of *Banksia* for amenity use, but only three for cut flower production, and all are propagated vegetatively to perpetuate their superior varietal characteristics. The ten named cultivars were derived from open pollinated populations under cultivation, and none are from controlled hybridization.

Of the seven cultivars for environmental horticulture, three are prostrate forms. *Banksia* 'Celia Rosser' is derived from an open-pollinated seedling of *B. canei*. It has deeply lobed leaves, a prostrate growth habit, and yellow inflorescences. *Banksia* 'Australora Pygmy Possum' is a coastal low-growing form of *B. serrata*, and *Banksia* 'Roller Coaster' is a prostrate variant of *B. integrifolia*. The other four cultivars have the more usual upright habit of *Banksia* species. *Banksia* 'Limelight' is a sport of *B. ericifolia* with lime green foliage, *Banksia* 'Giant Candles' is an interspecific hybrid between *B. ericifolia* and *B. spinulosa* var. *spinulosa* that arose in cultivation, *Banksia* 'Lemon Glow' is a yellow-flowered form of *B. spinulosa* var. *cunninghamii*, and *Banksia* 'Birthday Candles' is a dwarf form of *B. spinulosa* var. *spinulosa*. All of these varieties are for garden use, with *Banksia* 'Birthday Candles' for pot and garden cultivation*. Our research has developed the three terminal-flowering cultivars now to be released as announced on page 43.

A. Flowering

Floral initiation of the species *Banksia coccinea*, *B. menziesii*, *B. hookeriana*, and *B. baxteri* occurs between October and December, the southern hemisphere late spring and early summer. Although floral initiation occurs at roughly the same time of year in all four species, flowering does not, and the main difference between them is in the rate of development of the initiated inflorescences. This is very important commercially, as it means that pruning must be carried out prior to October, even in the late-flowering species such as *Banksia coccinea*, or the grower risks removing initiated blooms for the next year's harvest. Only the thickest shoots will initiate an inflorescence, and the likelihood of a shoot producing a bloom is correlated with shoot age and shoot size. The age of a shoot is determined from the number of bud scar rings, with two-year-old shoots having a ring of bud scars at the base, and another ring half way along the shoot. Most blooms are produced on shoots that are two years old, with only a minority produced on one- or three-year-old shoots.

*Cultivation of *Banksia* 'Birthday Candles'. Our first 'Birthday Candles' is around the back of the house beside the steps. It looks lovely there and has grown well in two years. It now has eleven flower spikes and is spreading nicely. Of course we now must have one around the front for everyone to marvel at. Anne and David Rees, Mirboo North, Victoria. Photo on page 88.

Each *Banksia* shoot must be allowed to develop for two years before a bloom can be expected, and some shoots never produce blooms. These are thin and weak compared with those that do, and there is a minimum shoot diameter, measured at the bud scar ring at the base of the current flush growth, which must be achieved for a shoot to flower. The critical diameter is 4.5 mm for *B. coccinea*, 6 mm for *B. menziesii*, 8 mm for *B. hookeriana*, and 11 mm for *B. baxteri*. High light intensity is also important for successful flowering of *Banksia*, with pruning to prevent shading an important consideration. This has led to a:

Pruning strategy for *Banksia**. Pruning is conducted immediately after flowering. If the inflorescences are harvested for blooms or for seed, then leaves are left on the branch to produce new flowering shoots for the future. All thin shoots are removed as they likely will not bloom. If a branch has two sets of bud scar scales, indicating it is two years old, and has not flowered, then it is removed. Only the thickest shoots are left on the plant as these have the best chance of flowering.

Grower's Tip:
Pruning is an essential gardening practice

Floral Initiation in the southern hemisphere late spring or early summer indicates that the environmental cues of increasing temperature and daylength may be important. This has been confirmed by experiments in which plants of *B. coccinea* and *B. hookeriana* were grown in environmental growth chambers, with full control of temperature and daylength. Four sets of conditions were imposed, with 8 and 16 h daylength, each with two temperature regimes of 15/10°C (day/night) and 25/20°C. For *B. coccinea*, most floral initiation occurred at 16 h 25/20°C and 16 h 15/10°C, with less initiation at 8 h 15/10°C and none at 8 h 25/20°C. This indicates that long daylength may be the environmental trigger for flowering in this species. For *B. hookeriana*, both the 16 and 8 h 25/20°C treatments stimulated flowering, with no floral initiation at 15/10°C with either 16 or 8 h daylength. This indicates that for *B. hookeriana* temperature has the major control over floral initiation.

Manipulation of *Banksia* flowering, to induce early or late flowering or to extend the production season, is not currently practised, but these research results introduce the possibility for extension of the flowering period of *B. coccinea*. By using supplementary lights to increase the natural daylength during winter, it may be possible to induce the plants to initiate earlier, and so possibly to flower earlier. Extension of the flowering period by inducing late initiation is more of a problem, as the plants would need short days at a time when daylength is increasing. While this is difficult in the field, it may be possible under protection. Manipulation of temperature, as required for *B. hookeriana*, could also be achieved under cover.

The *Banksia* bloom is an inflorescence comprising many hundreds of individual flowers; if initiation is incomplete, it can result in uneven or truncated blooms. Low temperature effects appear to be particularly common, correlating with abnormal blooms of *B. coccinea* and *B. menziesii*. Control is by careful site selection and provision of windbreaks or shelters.

*Pruning and care of *Banksia* is a very important part of their culture. Too many are left to grow leggy and sparse. They can be pruned very hard and a large shrub can be made an attractive small shrub by pruning large branches, a couple at a time to allow them to shoot before you attack the remaining ones. I have been frustrated over flowering but the revelation above will make all the difference, science in the back yard. I will remind members that they have contributed financially through the Australian Flora Foundation, to aspects of this scientific work. It was money well spent. Can you contribute to the Foundation's work? Editor.

B. Propagation of *Banksia*

Banksia seeds are encased by woody follicles in cone-like infructescences. The follicles of most species are adapted to open only after fire, although there are exceptions to this rule, including *B. marginata* and *B. integrifolia*. Heat generated during a wildfire melts adhesive material sealing the follicle, and the effect can be simulated in a fire or oven. A period of rain after the wildfire is important in some species, and this can be simulated by submerging the infructescences in cold water for between one and three days, followed by sun drying. In contrast to some other genera of Proteaceae, the seeds of *Banksia* species require no germination pre-treatment.

***Banksia* seeds** are generally large and rich in nutrients, and so tend to have high germination success rates. The temperature optimum for germination varies with species, from 18–23°C for *B. integrifolia* to 28–32°C for *B. aemula*, with 10–25°C the best range for *B. coccinea*. For germination of *B. coccinea*, *B. aculeata*, and *B. ornata*, 15°C is the optimum temperature, with 70% germination of *B. aculeata* seed at 25°C as compared with 100% at 15°C. Germination rate is slow, with first emergence after about three weeks, but taking up to three months for complete germination. After germination, seedling growth is fastest at 25°C.

Propagation of *Banksia* species by rooted cuttings is variable, and is based on semi-hardwood material collected following the spring growth flush, during the cooler months of the year. Some species will produce roots with no auxin treatment, although better results are achieved with 3,500 ppm indolebutyric acid (IBA) for most species. The highest strike rates for *B. coccinea* were achieved with 8,000 to 12,000 ppm IBA, and although some cuttings produced roots at all concentrations tested, root development was better with IBA than without. Genotype also influences rooting, with variation from 0 to 80% success for different individuals of *B. hookeriana* and *B. prionotes*.

Success with micropropagation has resulted in culture establishment of *Banksia coccinea*, *B. ericifolia*, *B. lemanniana*, *B. marginata*, *B. menziesii*, *B. ornata*, *B. prionotes*, *B. serrata*, and *B. spinulosa* var. *collina* from nodal segments and shoot tips.

There has been little consistent success with **grafting and budding** of *Banksia* species. Rootstocks used for experimentation are generally seedlings of *B. integrifolia*, *B. spinulosa*, and *B. marginata* that are tolerant of heavy soils and of the root rot fungus *Phytophthora cinnamomi*. A wedge graft on field-grown scions of *B. coccinea* and *B. menziesii*, which had been girdled four weeks prior to grafting had a success rate for both species between 30 and 40% at 20 weeks. A further complication is that grafts may survive for a number of years, with the union failing under conditions of stress. At present the success rate does not justify commercial use of grafting for *Banksia*, and further research is needed into graft compatibility.

C. Water and Nutrient Uptake

Most species of *Banksia* are native to the climate areas of south-western Australia, with some from south-eastern Australia and one tropical species that extends into New Guinea and the Aru Islands. All species grow best in light sandy soils of acid pH, and the south-western Australian species are particularly intolerant of heavy soils. Most are adapted to a hot, arid summer prone to bushfires, and have developed strategies to cope with these conditions.

Banksia are adapted to poor soils of low nutritional status, particularly phosphorus, and develop proteoid roots for increased nutrient absorption. Proteoid roots are specializations for solubilization of soil phosphates, and to increase the root surface area for absorption. In the native habitat they are major exporters to other parts of the plant of phosphate, potassium, and amino acids during the wet winter season.

The *Banksia* root system is dimorphic, with proteoid root-bearing shallow lateral roots in the top 15 cm, and a single tap or sinker root extends down to 7 m, or to the water table if located higher than this depth. Proteoid roots die during the arid summer, and regenerate during the wet winter of the native habitat, while shoot growth patterns are the reverse, with extension during summer. The amount of water required by *Banksia* plants of different ages has not been determined, but water stress can be a limitation to seedling establishment in the wild. Investigation of xylem and phloem sap of *B. prionotes* indicates that lateral root xylem sap is more concentrated in virtually all solutes than that of sinker roots, even during the dry summer following senescence of the proteoid roots. Gradients in xylem sap concentration suggest lateral abstraction and storage of incoming phosphate in basal stem parts during winter with subsequent release to the xylem in summer for the growing period. Phloem sap is more concentrated than xylem sap in nutrient ions and amino acids.

Under cultivation, phosphorus toxicity can be a problem for *Banksia* species, with symptoms reported in cut flower plantings with soil levels of greater than 40 ppm. In a detailed study, interactive effects between phosphorus and iron have been reported in *B. ericifolia* subsp. *ericifolia* grown in soil-less potting medium. As the phosphorus level was increased, iron deficiency symptoms increased, indicating preferential translocation of phosphorus over iron. The ideal ratio of phosphorus to iron in the medium was around 20, in media containing less than 3 mg/L phosphorus and 1.5 g/L iron. An important feature of *Banksia* biology is that high levels of nutrients are concentrated in seeds to give seedlings an advantage in the poor native soils of Australia.

D. Postharvest Physiology

Relatively little research has been conducted on preservative or pulsing solutions for fresh *Banksia* cut blooms, but sucrose pulsing generally does not enhance quality or longevity, and concentrations above 2% are detrimental. Work with *B. coccinea* found no effect of sucrose pulsing, with blooms having a vase life of 15 days in water plus 0.01% chlorine. Hydroxy quinoline sulphate is detrimental, as it causes reduction in vase life and accelerated opening of the florets. Cold dry storage is possible at 2°C and 100% relative humidity in darkness for 14 days, after which there is a 10-day vase life.

Research aimed at postharvest insect removal has tested a range of measures. Conventional disinfestation methods involving chemical control have no phytotoxic effects on *B. hookeriana* blooms, but there is a need to develop alternative methods for safety reasons. Gamma irradiation is unsuitable because it damages *Banksia* blooms, as do volatiles such as acetaldehyde, although to a lesser extent. Low temperature and high carbon dioxide treatments show promise for *Banksia* stems, as all test insects are killed by 10 to 14 days storage at 1°C, with a reduction to seven days if 45–60% CO₂ is combined with the low temperature treatment. *B. hookeriana* has an acceptable vase life following treatment of up to 28 days at 1°C. Hot water dips are less successful, with *Banksia* blooms damaged by all treatments that kill insects.

Banksia flower heads are often dried Lower-quality blooms unsuitable as fresh stems are often used, but *Banksia* is also grown to meet this market demand. For natural drying the blooms are hung, and the process can be accelerated by solar heating, hot air dryers, dehumidifiers, microwaving, freezing, and dehydration using silica gel. The colours of both flowers and leaves fade under these conditions, and sulfuring to preserve colour is achieved either by burning elemental sulfur or by using sulfur dioxide gas in an enclosed area. The orange *Banksia* species and *B. menziesii* respond well to sulfuring. Stems can be bleached using hypochlorite, chlorite, peroxide, or hydrosulfite, or preserved by placing in 10% glycerine for 24 h before drying. This latter treatment gives a shiny gloss to the dried product, which retains flexibility. It is not suitable for cut blooms, as these damage easily when treated with glycerine.

Dyed *Banksia* blooms are popular for some markets. Blooms of pale-coloured species such as *B. baxteri*, *B. speciosa*, and the unopened buff-coloured flowers of the orange species are dipped into aniline or water-soluble dyes. These impart a wide range of bright, vibrant colours, including blue, purple, orange, red, and green, or combinations. Uptake dyes produce more subtle colours but are not much used.

F. Culture

Banksia species are cultivated almost exclusively without protection and planted directly into soil. There has been little attempt at protected cultivation, although *Banksia menziesii* can be grown experimentally in nutrient solution. Between-plant spacings vary from 2 m for the more compact species such as *B. coccinea* to 3.5 m for the more spreading *B. speciosa* and *B. prionotes*, with between-row spacings of between 3 and 6.5 m. Windbreaks, weed removal, and rabbit protection are often used, and a mulch of a freely-draining medium such as gravel or coarse sand aids in protection of the roots from extremes of temperature. Drippers or microjets are the most efficient for irrigation, and tensiometer studies indicate that in Australia irrigation of 4 litres per plant per day is advisable in all except the winter months. Application of nitrogen, potassium, and iron are important, but high levels of phosphorus are generally avoided, with slow-release low-phosphorus fertilizer used in most nurseries. Healthy growth has been recorded with 0.5 g urea plus 0.5 g potassium chloride applied per plant through the irrigation system every six weeks, with 1 g ammonium nitrate and 1 g potassium sulfate per week during the active growth and flowering period. Iron chelate is also applied when chlorosis is a problem.

G. Diseases and Pests

The most important disease of *Banksia* species, both in the wild and under cultivation, is root rot caused by the pathogen *Phytophthora cinnamomi*. The disease is soil borne, and is readily transmitted on feet, vehicles, tools, and by water. In the nursery, the disease causes damping off of seedlings. In the field, poor growth is followed by drying and wilting of the foliage, because by the time above-ground symptoms are visible, the root system has been heavily colonized. In addition to dead roots, there is often collar rot at ground level. It has been recorded that a number of other *Phytophthora* species infect *Banksia* plants, particularly in nurseries. These include *P. dreschleri* Tucker, *P. nicotianae*, *P. cactorum* and *P. citricola*. Control of *Phytophthora* is very difficult and its introduction to a site must be avoided. It is impossible to eradicate the disease once it is established, and it can survive in soil without a host for many years.

Development of *Phytophthora*-tolerant cultivars may be possible, as there is species variability. Tolerance screening requires an effective non-destructive method, and an excised root assay appears to be the most reliable. Another promising approach is the use of antagonistic biological control agents. Grafting of susceptible types onto tolerant species has been suggested as an alternative control measure for the field, but grafting success to date has not reached commercial levels. Chemicals can be used to combat *Phytophthora*, but eradication of the fungus from infected land may produce phytotoxic effects.

Banksia species are attacked by relatively few pests, and most are insects that cause damage to the blooms or seeds. Tunnelling moth larvae (*Arotrophora* spp.) are the most common of the *Banksia* flower caterpillars, both under cultivation and in the wild. The adult moth lays eggs on immature blooms and the larvae move into the centre of the inflorescence stem and kill large numbers of flowers by feeding on the soft tissue. The larvae pupate in the flower stem, and control is difficult because they are protected within the inflorescence rachis. Larvae of a number of Lepidopteran genera may cause damage by feeding on flowers, including *Cryptophasa* sp., *Peraglyphis idiogenes*, and *Xyloryctis* spp. The Coleopteran *Myositta* has been reported on *B. menziesii* flowers in the wild, and leaf damage can be caused by the chewing snout beetle, *Catasarcus* sp. In contrast to the small number of flower predators, a wide range of insect genera has been recorded feeding on seeds within the *Banksia* infructescence. These include Lepidopterans of the genera *Arotrophora*, *Chalarotona*, *Scierpepla*, *Xyloryeta*, *Xyloryctis*, *Brachmia*, and *Carposina*, the Coleopterans *Alphitopis nivea* Pascoe, *Cechides amoenus* Pascoe, and *Myositta* spp., and unidentified Coleopteran weevils.

Banksia seeds form part of the natural diet of parrots and cockatoos, and cones are often predated in cultivated plantings and in the wild. Predators include the crimson rosella, *Platycerus elegans*, and the yellow-tailed black cockatoo, *Catyporhynchus funereus*. Open blooms are often removed from the plant, as well as cones with developing seeds.

Conclusions

Banksia species are already established as cut flower crops and are accepted on international markets, demand currently exceeding supply. This situation will not continue indefinitely, and as supply increases quality becomes critical. There are strong environmental reasons why further research into *Banksia* biology is essential. Until the early 1980s, most *Banksia* stems for the cut flower market were bush picked from the native habitat and *Banksia* is still the second largest bush picked genus in Australia. This has resulted in major damage to natural ecosystems via disturbance, introduction of disease, and depletion of seed reserves. Soil and plant destruction is caused by access vehicles, and soil-borne diseases are spread on tires and footwear. The root rot fungus *Phytophthora cinnamomi* attacks a wide range of native genera, including *Banksia*, and is very readily distributed. The aerial canker diseases *Diplodina* sp., *Zythiostroma* spp., and *Botryosphaeria ribis* are spread via infected secateurs, and have been the cause of more recent concern. *Diplodina* cankers girdle branches and eventually kill the plant, the disease being most prevalent in stands aged over 12 years.

The visual appeal of *Banksia* blooms is unquestioned, but there are other features that will ensure continued popularity, including long shelf life and variety of colour and form.

Edible wattle seeds

of Southern Australia

by Bruce Maslin, *et al.**

Based on reports of their utilization as food by Aborigines and other salient features, 47 *Acacia* species have been identified that have potential for cultivation in southern semi-arid regions of Australia as a source of seed for human consumption. Eighteen species appear to have the greatest potential and their natural distribution, ecology, phenology, growth characteristics and seed attributes relevant to their use as a human food are discussed in some detail. However, research is required before plantations of *Acacia* species for seed/food production can be recommended. These include analyses, of possible anti-nutritional or toxic components, and taste appraisals of the seeds.

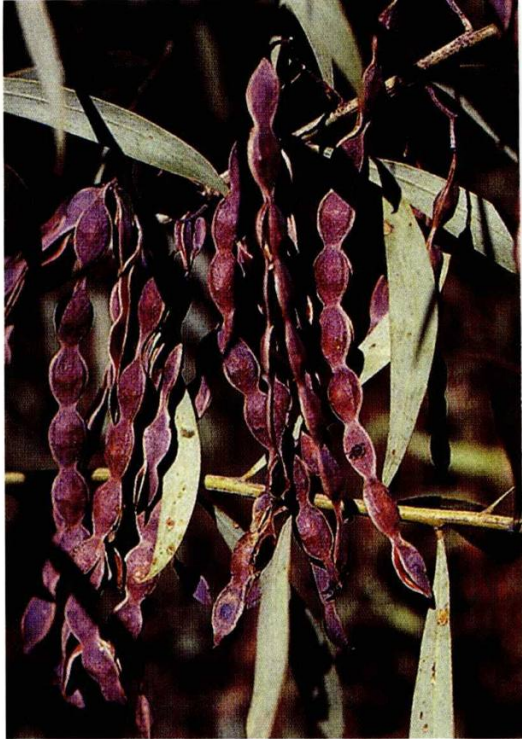
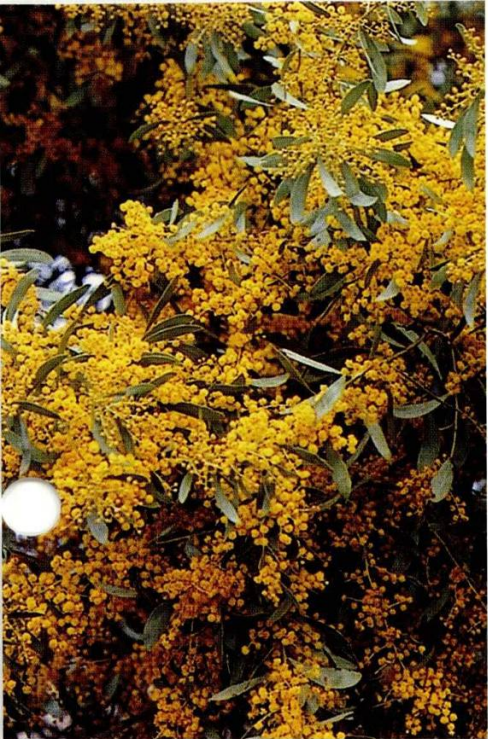
Acacia victoriae and *A. murrayana*, appear particularly promising for production of human food in southern Australia. The seeds of both species have good nutritional characteristics and were commonly used as food by Aborigines. Wild populations have wide adaptability, grow rapidly and produce moderate to heavy seed crops in most years. Both species are easily propagated from seed.

Temperate dry-zone *Acacia* for land care or for commercial return

The 350 species of *Acacia* of the temperate dry-zone of Australia represent an important, largely untapped genetic resource for revegetation and utilization of degraded and marginal farm lands in southern Australia, especially the Murray-Darling Basin and wheatbelt regions in south-western and eastern Australia. In these areas there is an increasing interest in complementing existing shallow-rooted annual crops and/or pastures with deep rooted, drought-tolerant perennial plants suited to utilization in these marginal lands and can contribute to reversing land degradation. *Acacia anthochaera*, *A. microbotrya*, *A. murrayana*, *A. ramulosa* and *A. saligna* are currently used in direct seeding mixes to revegetate degraded lands in the northern wheatbelt of WA.

Within Australia, the main economic utilization of temperate dry-zone acacias has been as stock fodder, especially during times of drought. Species utilized for fodder include *Acacia aneura*, *A. argyrodendron*, *A. estrophiolata*, *A. grasbyi*, *A. kempeana*, *A. pendula*, *A. pruinocarpa*, *A. saligna*, *A. stenophylla* and *A. victoriae*. The woods of many dry-zone *Acacia* species make excellent fuels. Certain species have specialty wood uses, for example *A. aneura* and *A. carnei* for handicrafts/turnery and *A. cambagei*, *A. papyrocarpa* and *A. pruinocarpa* for musical wind instruments such as bagpipes. In the goldfields area of Western Australia, both *A. papyrocarpa* and *A. aneura* are used for making high quality flute heads, additionally, *A. papyrocarpa* is used for making guitar fret boards and knife handles. Many species such as *A. acuminata* and *A. aneura* which produce hard, durable wood have been used for fence posts.

***Edible Wattle Seeds of Southern Australia**, A review of species for use in semi-arid regions. The article above has been extracted from this book by B. R. Maslin, L. A. J. Thomson, M. W. McDonald and S. Hamilton-Brown, produced by CSIRO Australia and Department of Conservation and Land Management, WA, 50 Hayman Rd., Como, WA, and may be obtained from them. A book of 108 pages it describes 47 wattle species which have potential for cultivation in southern semi-arid regions as a source of seed for human consumption. 18 of these are described and illustrated in colour with three pages per species. A valuable reference. Editor.



△ *Acacia microbotrya*, flowers and fruit with seed

▽ *Acacia prairiif* flower with sketch details

▽ *Acacia hemiteles*



Aboriginal Use Of *Acacia* Seed

Australian Aborigines traditionally utilized the seed of a large number of arid zone *Acacia* species as human food. The common method of preparation was to roast the mature seeds, grind them to flour with a little water and cook the resultant paste as a damper. Sometimes the whole green pods were either roasted or steamed (e.g., *A. linophylla* and *A. palustris*) and consumed in this form, or seeds were removed from the cooked pods and eaten with the "shells" discarded. For a very few species, seeds were taken from uncooked pods and consumed raw as a "snack" food (e.g., *A. craspedocarpa*).

Nutritional Value and Toxicology of *Acacia* Seed

The overall nutritional value of dry seed of Australian *Acacia* species is fair to good and is comparable to other legume seeds except for a higher level of dietary fibre. In one study the average composition was 23% crude protein, 26% available carbohydrate, and 32% fibre. Protease inhibitors (which inhibit protein breakdown into peptides) are present in *Acacia*, but they are deactivated by cooking the seeds, as was often practiced by Australian Aborigines. Potentially toxic non-protein amino acids such as djenkolic acid were found in some dry-zone *Acacia* species (*A. colei*, *A. elachantha* and *A. tumida*), but at levels well below those that would cause toxicity problems. Lathrogenic amino acids were absent. Other toxic and anti-nutritional factors such as cyanogens, haemagglutinins and heavy metals were absent or at very low levels in these species. However, very little is known of the levels of anti-nutritional or toxic components in the seeds of *Acacia* species. There is a clear need for a thorough research program to vindicate their increasing use as food additives and to determine their potential as nutritionally significant foods.

Australian ferns and related plants plus pines and cycads

Flora of Australia series, volume 48

Australia has 390 species of fern. All of these are described, fortunately in 103 groups or genera so as to make it easy. If seeking information on a fern and you do not even know its name or group you will be able to pick the group out by looking at the clear sketches. From this group of similar ferns you can pick out the fern you want. The descriptions of each fern are in botanical jargon but this will be no deterrent to fern enthusiasts who are already familiar with technical terms such as rhizome, the underground travelling root, fronds, stipes, etc.

Fern allies! There are 44 species all quite fascinating, just look at the sketches.

Australian pines! There are 43 species in 15 groups all described and illustrated.

Australian cycads! There are 69 species in 4 groups described and illustrated.

This is a massive book with 766 pages and the price of \$59.95 is very reasonable. Order it by mail through the Secretary of the Society in your home state.

Australian Plants for the Garden

by Gwen Elliot

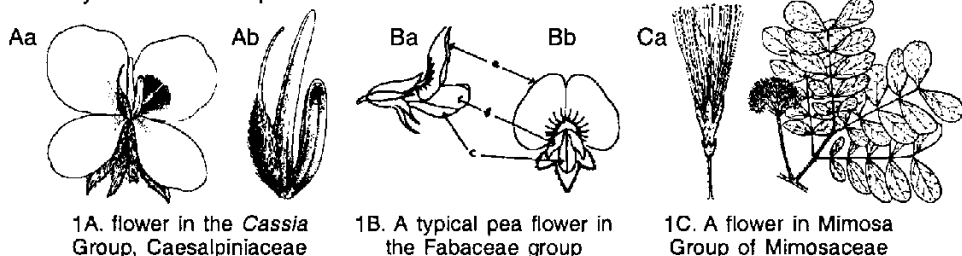
The introduction is a guide to the cultivation of wildflowers as garden plants, or in containers. The 128 page book is for successful gardeners using those plants that are showy and reliable. It will appeal to beginners in this area. The range of species described and illustrated is thus restricted and the book will not be of great assistance for those with some experience in the cultivation of our wildflowers. It is well illustrated by the excellent photography of Rodger Elliot. It is available at your book seller or your state Society for \$14.95 plus \$6 postage.

Legumes of Australia

Introduction by J. H. Ross*

Legumes belong to the plant family Leguminosae, a very large family of plants, important economically to humans through the ages. The unique feature of all plants in the family is the legume (fruit) in which the seeds are generally attached in two rows along the upper suture. The basic type of fruit is a pod with two valves that separate and twist when mature, to disperse the seeds, but this is variously modified to encourage dispersal by water, wind and animals.

The Flora of Australia has adopted one modern line of thought by dividing this vast complex of plants into three families, Mimosaceae, Caesalpinaceae and Fabaceae. These families may readily be distinguished by the flower shape.



The **flowers of Caesalpinaceae** were introduced in our last issue, *Labichea* and *Petalostylis*, but the most widely known are the *Cassia*. Flowers of plants in this family usually do not have petals of the same size and shape and in bud they are generally imbricate (overlapping each other at the margins) the central (adaxial) petal being overlapped by the adjacent petals; leaves usually bipinnate or pinnate.

The **flowers of Fabaceae** are of the pea-shape as illustrated in the last issue for *Pultenaea*, and for *Oxylobium* on the next page. in this case the central petal, the standard, is outside or overlapping the adjacent wing petals. The sepals are united at the base. The seed of Australian species is hard with a prominent white radicle that recurves or clings to the seed body. The leaves can be very variable.

The **flowers in Mimosaceae** are regular, that is there is a ring of similar petals surrounding the stamens with the style in the centre. The petals are small and often unnoticeable on the mature flower but in bud they are valvate (touching at the margins and not overlapping but often united at the base). The most noticeable feature of the individual flower is the many stamens and when grouped in a head of flowers they form a pom-pom or sausage of flower as in our wattles. This issue presents the groups of plants in Mimosaceae.

*Dr. Ross, Royal Botanic Gardens, Melbourne has published an account of these families in *Flora of Australia*, Volume 12, see page 70 for details. Descriptions of the species in Mimosaceae have been prepared by the Editor based upon this work with further details for plants marked Φ by Garry Sankowsky. *Australian Plants* will present this family of plants in small groups as continued on page 62. Editor.

Pea-flowers of the high country*

Plant family Fabaceae

Oxylobium alpestre, Alpine Shaggy-pea
and *Oxylobium ellipticum* Common Shaggy-pea

PRONUNCIATION: ox-il-OH-bee-um
al-PES-tree; eIIP-tic-um

MEANING:

Oxylobium = sharp pod;
alpestre = alpine;
ellipticum = elliptical

FAMILY:

Fabaceae;
peas, beans.

KEY CHARACTERS:

Shrubs (sprawling, less than a metre for Alpine; erect, to 2 m for Common). Stiff leaves in pairs or threes, with down-rolled edges (to 4 cm long smooth, below, for Alpine; to 3 cm long, white haired below for Common). Striking orange-yellow flowers in short sprays in early summer. Buds and oval pods hairy.

SIMILAR SNOW COUNTRY SPECIES:

The less common Tall Shaggy-pea, *O. arborescens* is found at lower snow country altitudes, but not in the ACT; it grows to 8 m high and has leaves to 8 cm long.

HABITAT and DISTRIBUTION: In Snow Gum woodlands to just above the tree line, often in rocky situations.

COMMENTS: Both shaggy-peas are common Snow Gum species, very colourful in early summer. In 1995 an authoritative publication removed *O. alpestre* from the genus *Oxylobium*, describing it as *Podolobium alpestre*. It is likely that this will be generally adopted in time.

***Wildflowers of the Snow Country.** *A Field Guide to The Australian Alps* is a new book and the above is a reproduction of a page from it to show just what the presentation is. This page is headed Flowers mostly yellow, not symmetrical, e.g., top half of flower very different from bottom half. The introduction describes how you can identify the plants from flower shape and colour. The 186 pages are similar, describing a plant of the alpine area and illustrating it with a water colour painting by Helen Fitzgerald, as above. Compiled by Ian Fraser and Margaret McJannett, it is available from Vertego Publications, G.P.O. Box 3268, Canberra, ACT, 2601, for \$24 plus postage. A valuable field guide for those walking the area. Review by Editor.



Oxylobium robustum

Flower and plant, growing in the editor's garden. It is spectacular in spring, easily grown from seed sent to me by a member. I have it growing all over, in the open as a specimen shrub and in my light eucalypt forest area. Flora of NSW advises that it is the Tree Shaggy Pea often growing to 3 m tall. For me it grows to 1 m but I do prune all my shrubs. It grows north from Newcastle to Queensland. Will readers advise of the best plants in their garden hopefully with a photograph. Why not make this a series in each issue? Editor.



Mimosaceae in Australia is represented by 12 naturally occurring genera. The family has been split up into five tribes three occurring in Australia.

The **tribe Acaciaeae** or *Acacia* group are widely known and grown with more than 1,000 species, see page 56.

The **tribe Ingeae** has some genera that have been confused with *Acacia*. The flowers have numerous stamens that are the showy part of the flower but these are usually longer and united at the lower end of the filaments to form a short to long tube, see figure 3, page 63. Genera in this group include *Albizia* and the similar *Paraserianthes*, *Archidendron*, *Archidendropsis*, *Cathormion* and *Pararchidendron* as described on page 62.

The **tribe Mimoseae** is distinguished by flowers with a definite number of stamens (c.10) which are free from one another. They are:

Adenanthera leaves are bi-pinnate but distinctly alternate, not opposite. The pod opens on both surfaces, not coloured within, producing seeds scarlet or red and black. *Adenanthera abrosperma*, is found on Cape York Peninsula south to Chillagoe, a tree 5–14 m tall, with cream flowers aging to orange-yellow. The distinguishing features are shown in figure 3. *Adenanthera pavonina* (photograph on page 65) may be distinguished by flowers in racemes, i.e., many loosely held along a "stalk", not a tight spike opposite. It is widely cultivated and recorded in Flora of Australia as naturalized. It is most definitely, an Australian native. Like many Asian plants, Australia is the southern distribution limit and it may be found growing naturally on Cape York south to Townsville.

Dichrostachys shrubs or small trees, distinguished by features shown below, the white to cream flowers in spikes, the leaves (with 5–9 pairs pinnae) attached as shown with additional parts and a thorn at the point of attachment to the stem.

Dichrostachys spicata, is a shrub to tree 1–3 m tall, from across the north from Exmouth in WA to Chillagoe in Queensland. Figure 2 below shows **A** a node with leaves, additional parts with a spike at the point of attachment; **B** the peg-like nectary; **C** a flower head of white flowers; **D** pods, **E** a seed.

Dichrostachys cinerea is similar but taller to 8 m, distinguished by its more numerous narrower leaflets 12–24 pairs 1.5 mm wide as against *D. spicata* with 5–7 pairs, 2–8 mm wide. It is found in the NT.

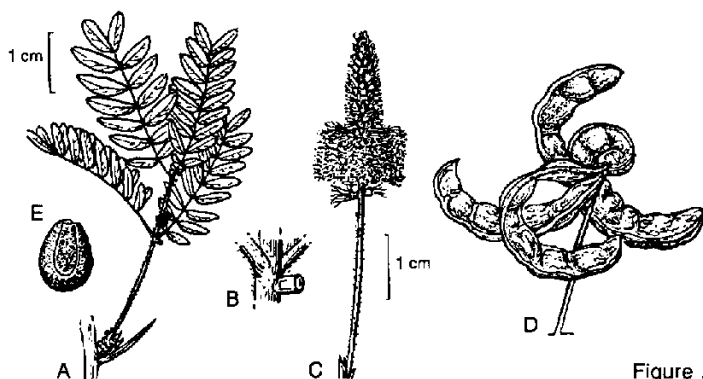


Figure 2

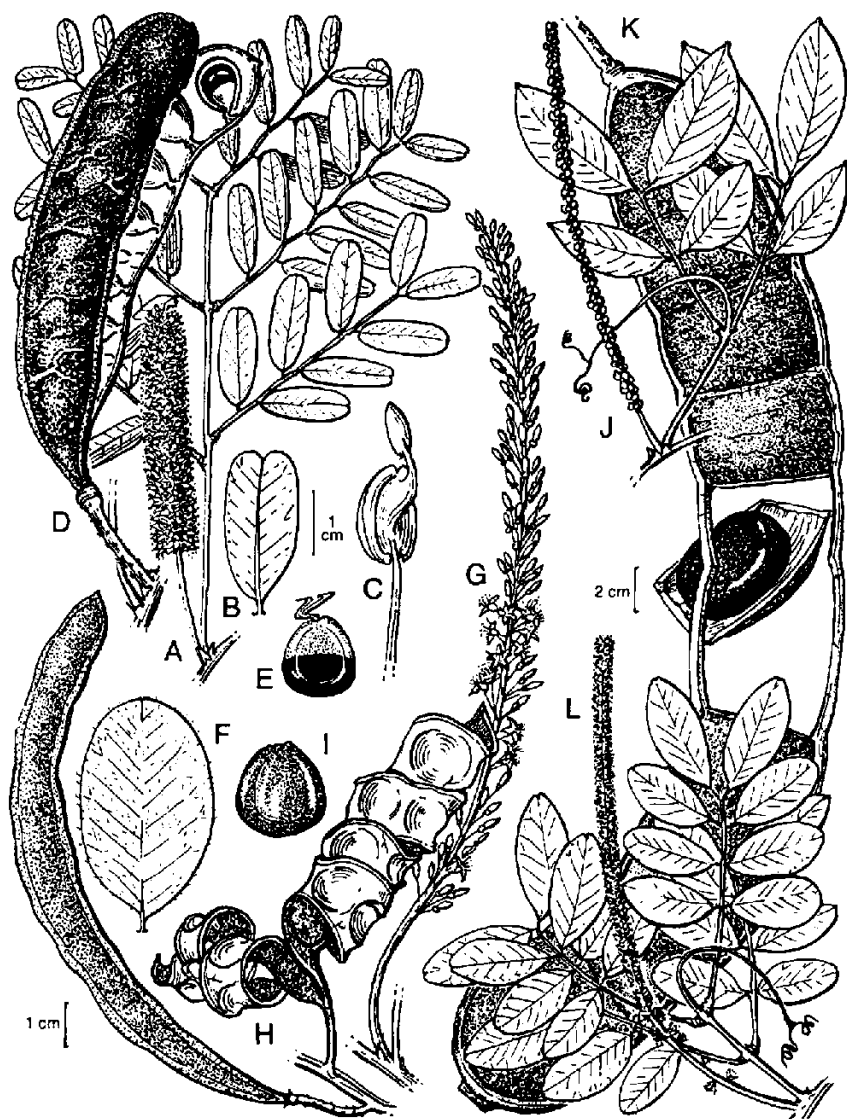


Figure 3. *Adenanthera abrosperma*; A node with leaf and inflorescence; B leaflet; C anther with stalked gland; D pod; E seed.

Adenanthera pavonina; F leaflet; G inflorescence; H pods, one open; I seed.

Entada phaseoloides; J a node with leaf, climbing tendril and flower head.

Entada rheedii; L a node with leaf, tendril and flower head, noticeably more leaflets and usually smaller than those of *E. phaseoloides*; K pod with one segment showing woody innermost layer (as against a parchment-like layer for *E. phaseoloides*) and a seed.



Scarlet Bean. *Archidendron lucyi* growing as a street tree in Cairns. The photographs were taken by the Editor some years ago. There is an important lesson here. Most rainforest trees, when grown as specimen trees, assume a smaller stature than they do growing in the wild where they are reaching for their share of the sun's rays. They also appear fairly hardy and can be used as small specimen or shade trees. The scarlet beans make it very attractive, see page 74.





△ *Adenanthera pavonina*, see page 62 ▽ *Cathormion umbellatum*, see page 76

▽▽ Tulip Siris, *Parachidendron umbellatum*, see page 76

Photographs by Garry Sankowsky



Plants in the Family Mimosaceae, tribe Ingeae with numerous stamens

Albizia. A group of four Australian species somewhat resembling wattle, the leaves being similarly divided but with more rounded opposite pinnae as shown in figure 1. The individual flowers are similar, white to pale yellow but are displayed in less compact heads. They are found in the wild across northern Australia, fast growing trees that can be kept to a medium size for a shade tree. The flowers are not showy but nicely perfumed, they attract butterflies.

Albizia canescens, figure 4W. 3–10 m high in the wild but adaptable, growing in clay to sand. A, leaves and inflorescence; B, a leaflet with appressed hairs.

Φ *Albizia lebbbeck*, figure 4X, is a native to Australia (despite it being recorded as a naturalized non-native in *Flora of Australia*). The foliage of the Australian variety is distinctly different from the Asian ones and may be distinguished by smaller leaves half the size, leaflets in 8 pairs, 1.5–4.5 cm long, 0.6–3.5 mm wide. All those occurring around homesteads and in parks are of the introduced variety but in remote areas of Cape Yorke Peninsula, NT and Northern WA, are natives. The Australian variety in figure 4B opposite has G, twig with leaves and inflorescence; H, a leaflet, I, nectaries on leaf axis; J, flower; K, pod; L, seed.

Albizia procera, figure 4Y, 'Women's Tongues' (photo page 68), a pioneer plant usually in disturbed areas. It is slender spreading tree 3–18 m grown in Darwin as a semi-deciduous fast growing tree, M, leaves and flower head; N, is a leaflet.

Φ *Albizia retusa*, figure 4Z, (photo page 68) is the most attractive. It is unusual in that the male flowers are pink and the female ones white. It can be a good shelter tree in tropical areas although it grows to 40 m in the wild. S, a twig with leaves and flowers; T, a leaf without hairs; U, nectary on leaf axis; V, a flower.

Neptunia. Five species are native, all terrestrial or aquatic herbs, native to the tropical northern areas. The differences are shown in figure 8, page 84. Not shown are *Neptunia gracilis* which is usually prostrate with a 3–8 seeded pod, and *N. major*, a multi-stemmed shrubby herb to 3 m tall.

Neptunia dimorphantha 'Sensitive Plant'. A plant for a rockery. The fern-like leaves fold when touched. Produces large golden balls similar to wattle flower balls. Grows prostrate to 0.8 m diameter under cultivation. Acts as an annual but has a perennial root which originates new growth in spring.

Continued on page 84

Editor's note. These descriptions are based upon Volume 12 of *Flora of Australia* and rely heavily on the artistic talent of Milton Andrews for the sketches. Those species marked Φ and most that follow, contain additional comment from Garry Sankowsky. His observations are based upon years of experience of northern Australia and his reports are widely valued.

Australian Tropical Plants, Volume 1

This is a compact disc available from the Yurunga Nursery, P.O. Box 210, Tolga, Queensland for \$40 plus postage of \$3. It contains vast amounts of data on 524 species of Australian tropical plants with over 1,200 true-colour pictures, up to three for each species. By selection you can make lists of plants based on flower colour, perfume, those suitable for a specific area such as yours, bush tucker, survival rating, attracts birds, attracts butterflies, use as shade trees, ground covers, you name it all this information is available on your printer screen or on a print out. An incredible, authoritative reference available due to the unselfish generosity of Garry. He produced this compact disc as a private venture the income going to the production of further volumes in the series. He needs your support, you need the information or just to see the priceless pictures, buy one. Editor.

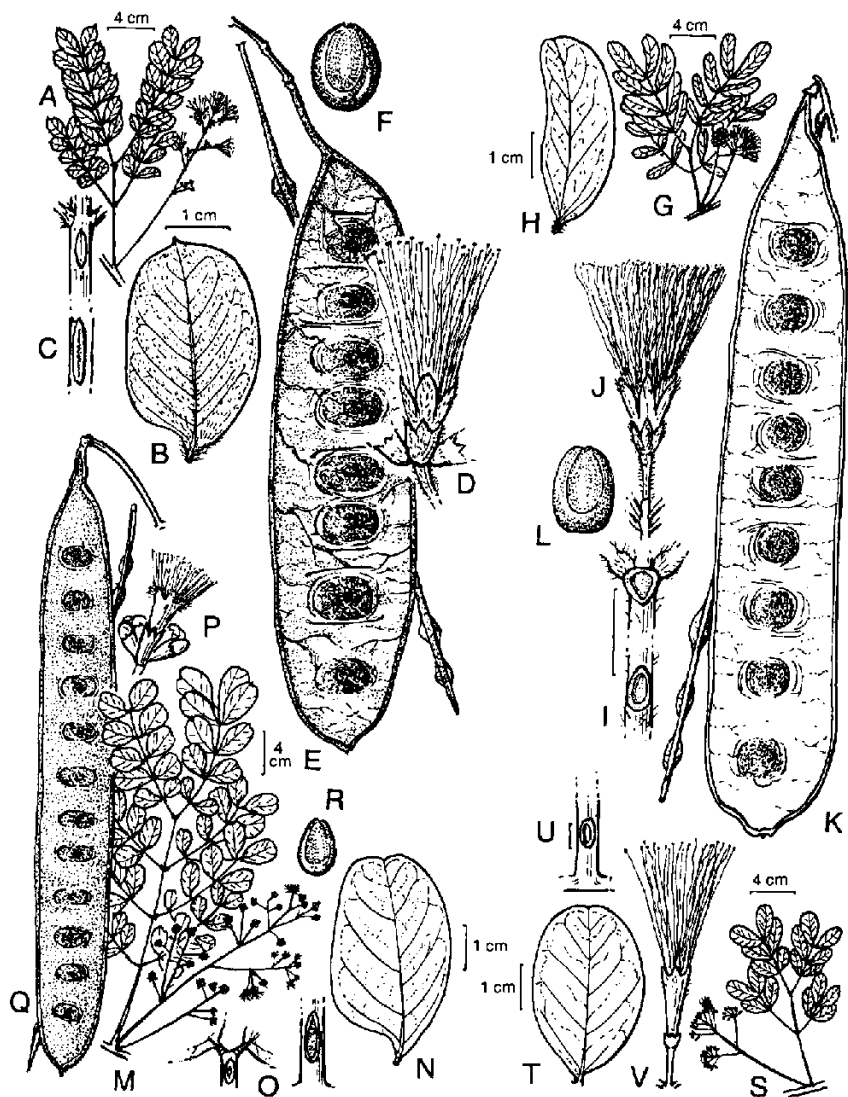


Figure 4

Sketches by Milton Andrews

W *Albizia canescens*, A leaf and flowers; B leaflet; C nectaries; D flower; E pod; F seed.

X *Albizia lebbeck*, G node with leaf and flowers; H leaflet; I nectaries; J flower; K pod; L seed.

Y *Albizia procera*, M leaf and flowers; N leaflet; O nectaries; P flower; Q pod; R seed.

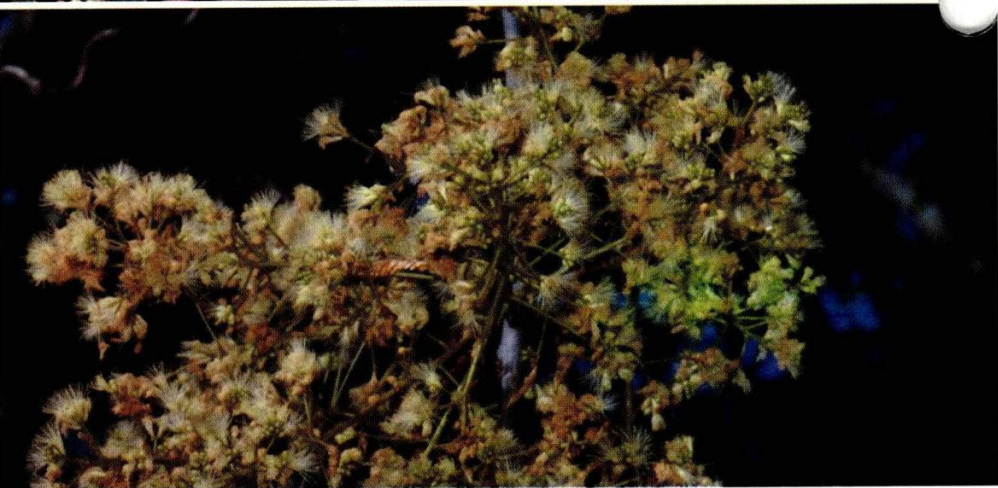
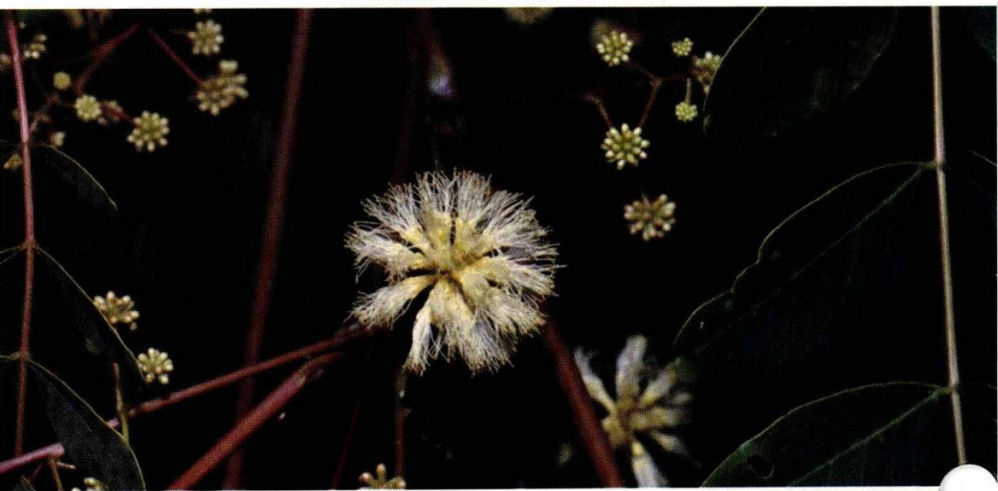
Z *Albizia retusa*, S node with leaf and flowers; T leaflet; U nectary on leaf axis; V flower.



△ *Albizia retusa*,
see page 66

▽ 'Women's Tongues', *Albizia procera*,
see page 66

▽▽ Mackay Cedar, *Paraserianthes toona*, see page 70
Photographs by Garry Sankowsky





△ *Archidendron hendersonii*,
see page 73

▽ Cape Laceflower,
Archidendron hirsutum

▽▽ **Topaz Laceflower, *A. ramiflorum***, see page 74
Photographs by Garry Sankowsky



Paraserianthes are unarmed trees and shrubs previously known as *Albizia*. They more closely resemble the wattles. The flowers are carried in distinct spikes.

Paraserianthes lophantha Cape Wattle previously known as an *Acacia*, *Mimosa* or even *Albizia*, native to south-western WA in coastal areas of Gingin Brock and west, it has become naturalized in coastal areas in NSW from Dorrigo south to Tasmania. It is widely cultivated in tropical areas around the world and used as a street tree. It can be grown as a shrub or a tree to 10 m tall. Characteristic features are shown in figure 5V, the leaf at a node (point of attachment) in detail A, the leaf divided into many (20–40) leaflets (pinnae) and two flower spikes (inflorescences) shown larger in B one still in bud the other opening from the bottom, comprising many individual flowers shown enlarged in D. B is the nectary on the leaf rachis (stalk); E is the pod that contains seed F.

Paraserianthes toona Acacia Cedar, Red Cedar or Mackay Cedar (figure 5W, photograph on page 68) has been known as an *Albizia*. It is a large rainforest tree 3–24 m tall with a trunk to 1 m diameter. Very fine, attractive, dark green foliage adorns this hardy plant which makes a handsome shade tree in full sun. It is recommended for planting right across the top and down to northern NSW. Unlike many trees, the foliage shape remains the same from seedling to the adult stage. It is a host plant for the Tailed Emperor butterfly. It is found in dry to wet rainforest and at low altitudes, from Thursday Island south to Sarina, Queensland. The characteristic features are shown in figure 5W, the leaf at a node with smaller even more divided leaf than above, 26–58 pairs of leaflets, an inflorescence of tiny flowers in yellow fluffy balls, reproduced in I each individual flower as in J; K a pod carrying seed L.

Archidendropsis are large shrubs to tall trees native to Queensland.

Archidendropsis basaltica, figure 5X, is from the Rockhampton area extending some distance north, west and south. The leaves with 5–11 pairs of leaflets, many with red hairs are as in M shown on a node with a rounded flower head (inflorescence), the nectary is on the leaf stalk (rachis) as in N showing characteristic spikes and nectary. The brownish pods O open along both sides enclosing seeds P which have a narrow, peripheral, membranous wing.

Archidendropsis thozetiana, figure 5Y, is from the Townsville area extending to Gympie in the south and Emerald in the west. The leaves with few leaflets (2–4 pairs) are as in Q with a head of cream to yellow flowers attached at the node; the nectaries are at the leaflet attachment point; the pod S enclosing seeds T.

Archidendropsis xanthoxylon from a restricted area north and west of Cairns. The differences are shown in the figure 5Z, larger leaves often with only one or two pairs leaflets, V the individual flowers, the pod X carrying seed Y.

Flora of Australia, Volume 12, Mimosaceae (excluding *Acacia*) and Caesalpiniaceae.

The basis of the plant descriptions and all the sketches shown here were taken from *The Flora of Australia*, a series of scientific publications describing in volumes, the flowering plants of Australia. Volume 12 presents all plants allied to our wattles, *Acacia*, (the *Acacia* are not in this volume) and all plants allied to *Cassia* many of which are now known as *Senna*.

Scientific publication? yes, but not really. Information in this form presented here may be readily taken from the descriptions of the 153 species described so it is not a book solely for scientists. The sketches here are also reproduced from the volume and it is immediately apparent that you do not have to plough through the scientific descriptions but can identify the plants easily from these excellent sketches. A very valuable reference for \$54.95 from CSIRO Publishing P.O. Box 1139, Collingwood, 3066.

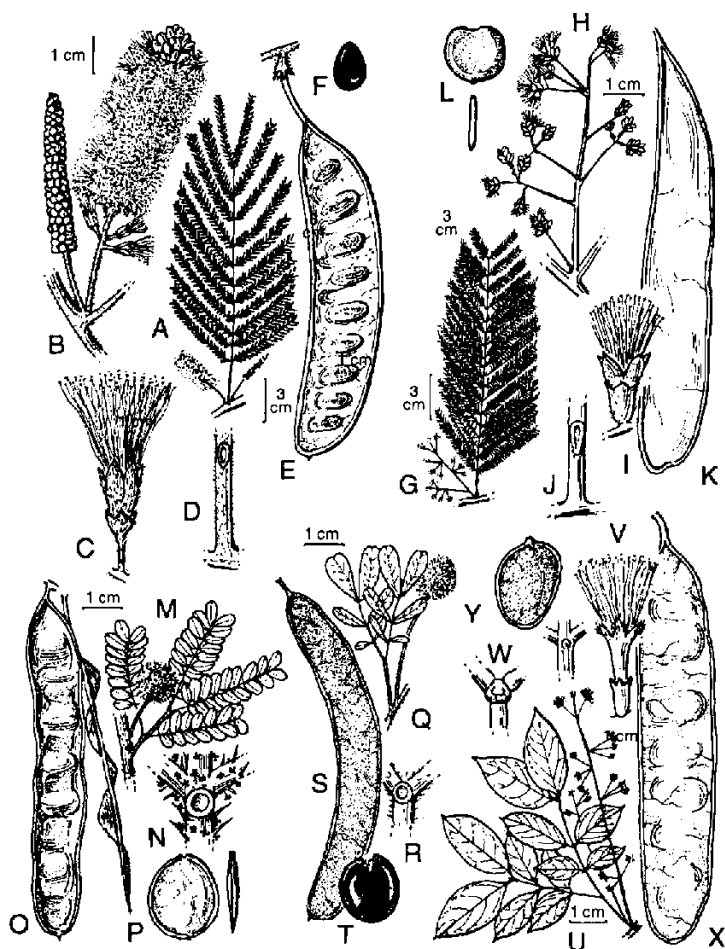


Figure 5

Sketches by Milton Andrews

- V *Paraserianthes iophantha*, A leaf and flowers (2 inflorescences) as at B, flowers heads in bud and almost fully opened each flower as in C; D nectary on leaf stem (rachis); E pod, F seed.
- W *Paraserianthes toona*, G leaf node with one flower head as in H, each flower as in I; the nectary is on the leaf stem as in J; the pod K contains seeds as in L.
- X *Archidendropsis basaltica*, M leaf at node with flower head containing individual flowers as in V; N nectary on leaf stalk; the pod O and P (side on) contains seed as in N.
- Y *Archidendropsis thozetiana*, Q a leaf at node with a flower head comprising individual flowers as in V; the nectary on the leaf stalk; the pod S contains seeds T.
- Z *Archidendropsis xanthoxylon*, U a leaf at node with a spray of flowers each as in V; the nectary W is on the leaf stalk; the pod X contains seed Y.



Fairies Paintbrush, *Archidendron grandiflorum*, flowers $\triangle$ and fruit ∇
Photographs by David Hockings who advises that this is the most outstanding of them all.



Archidendron has 10 species in north-eastern Australia, 6 of which are shown in colour in plates of *Flora of Australia*, volume 12. The first two below are distinctive as the leaflets are hairy, at least on the lower surfaces whereas the other 8 species have no hairs on the leaflets.

Archidendron hirsutum, Cape Laceflower, (photograph on page 69) is a tree to 22 m tall in moist (monsoon) rainforest from Coen north to Cape York but in cultivation is very hardy shrub that will survive with very little attention. Most parts are more or less densely covered in brown hairs, sometimes quite short or velvety producing attractive foliage. The terminal heads of 10 flowers, are 13 cm long, each flower with long pinkish stamens, without a very conspicuous display. The flower head can be quite attractive, especially to birds and butterflies. The spirally contorted pod is red outside and yellow or orange inside, the seeds black.

Archidendron lovellae is a tree to 20 m tall with parts appearing covered in a brownish velvet. It is restricted to littoral rainforest in dune swales from Fraser Island south to Gympie. The flowers are attractive, a number in a head of 5–6 on a stalk and arranged in groups or a cluster. The long stamens are red to maroon, white at the base. The woody pod is bright red inside. It is similar to *A. grandiflorum* which has glabrous leaves. Reports of cultivation are needed.

Archidendron grandiflorum, figure 6W, Raintree, is a round canopied tree to 10 m tall that is usually found deep inside the rainforest as a large, spreading tree. When in flower or fruit it makes a wonderful spectacle. Flowering commences in October continuing right through summer with fruiting over the same period. It may be grown in all tropical areas and south to Sydney as a magnificent specimen tree with attractive foliage. In southern areas the perfumed white or yellow flowers attract large numbers of Richmond Birdwing butterflies and in some areas it is known as 'The Butterfly Tree'. In the north the Cairns Birdwing pays little attention to it. There are at least three distinct varieties, one from the dry monsoon rainforests of Cape York which is extremely hardy, one from the Wet Tropics and one from the southern Queensland, NSW area that will require water during dry periods. The leaves are pinnate with large oval leaflets being 6 × 4 cm as in Wa in 2–5 pairs. A distinguishing feature is the stalk nectaries on the leaf axis as in Wb; Wc is a head of flowers that form like pompoms in terminal clusters on the outside of the canopy, creamy white with pink tips shown about full size in detail Wd. The pod is orange often red inside, usually curling to almost a ring as in We to reveal black seeds as in Wf.

Archidendron hendersonii a tree to 30 m with corky bark. Photograph on page 69. It is similar to the species above which has more pairs of leaflets and larger flowers in each cluster. The pods are red /orange exposing black seed. There are two distinct variants from the type species. The Kuranda Laceflower occurs in moist to wet rainforest from Cooktown to Townsville and grows 2–4 m in height. This plant will often start flowering while still in a pot and only 10 cm high. In the garden it will usually flower two or three times a year. It performs best when planted in full sun but must be protected from dry winds. The Quion Hill form is known as Hopevale Laceflower as it is known only from the Hopevale area north of Cooktown, where it is a slender, understorey shrub with larger inflorescences. The flowers are distinctly different with shorter stamens. It will blossom in semi-shade but does best in full sun. They are followed by small yellow fruit.

Archidendron whitei Boonjee Laceflower, is a tree to 15 m tall restricted to the Atherton Tableland and the wet lowland rainforest to the east of it. Related to the above species it can be distinguished by a solitary leaflet (4–16 cm long, 3–7 cm wide) on each pinna as in figure 6 detail Ym, with the nectary on the leaf axis as in Yn. The perfumed, delicate flowers (they last only a few hours) Yp are small held in a loose spike as in Yo. The pod Yq is reddish and strongly warty, the seed is black. It is a very difficult plant to grow and it will die from lack of water, dry wind, hot sun or any other feeble excuse. however it grows more easily in milder climates.

Archidendron kanisii is a small tree or shrub to 3 m tall, known only from an area just south of Cape Tribulation to Little Cooper Creek, and again at Whyanbeel near Mosman. It is closely related to the above species but can be distinguished by a small circular nectary at the apex of the petiole, smaller and shorter leaflets and smaller flowers. It is a small, very delicate understory plant which is almost impossible to grow.

Archidendron muellerianum Small-flower Laceflower or Veiny Laceflower, is a tree or large shrub to 20 m tall. It is restricted to the rainforest behind the Gold Coast, extending south to the Richmond River in NSW. It is a very distinctive species because of its relatively small leaflets 3–10 cm long, 2–6 cm wide usually only with one pair, rarely 2 per leaf; white flowers in a compound umbel to 9 cm long. The pods are scarlet outside and brightly orange within, the seed glossy black. It is closely related to *Archidendron kansii*.

Archidendron vaillantii, Salmon Bean, figure 6Z, is an attractive tree to 25 m tall, 5–10 m in cultivation. During the first year this plant has a high water requirement but once it is well established it does not require much attention. The leaf is very large and easily damaged by winds. Figure 6, shows the nectary on the leaf axis Zt, the yellow flowers Zv are carried on a loose spike as in Zu, but together in a large head, the pod Zw, bright orange or reddish.

Archidendron ramiflorum, Topaz Laceflower, figure 6X, (photograph on page 69) is a shrub or tree 4–8 m tall, a little smaller in cultivation. When grown in good conditions, the huge leaves provide a splendid show. It must be well protected from dry winds and watered regularly and is suitable for semi-shade or full-shade areas as far south as northern NSW. It can be grown in full sun in very high rainfall areas. It is one of two species that carries its flowers (detail Xj) on the trunk and main branches as in Xi. The white perfumed flowers, which have extremely long stamens, can completely cover the trunk and the bright red fruit are the largest produced by any *Archidendron*. The leaflets are in 5 pairs, 9–44 cm long, 5–15 cm wide as in Xg. The pods are orange or red as in Xk with a sub-glossy black seed Xi.

Archidendron lucyi, Scarlet Bean, is a tree to 20 m tall with its white flowers and red pods on the trunk. In wet coastal areas this plant can be grown in full sun but in most regions it is best planted in semi-shade and reaches 3–5 m in height. It will require water during dry periods and must be protected from dry winds. It will also grow south to NSW. The leaflets are in 2, rarely 3 pairs 6–23 cm long, 3–11 cm wide. The white flowers are in a cauliflorous umbel, perfumed and attract birds. The pods are reddish externally and orange within with black seeds with white bloom.

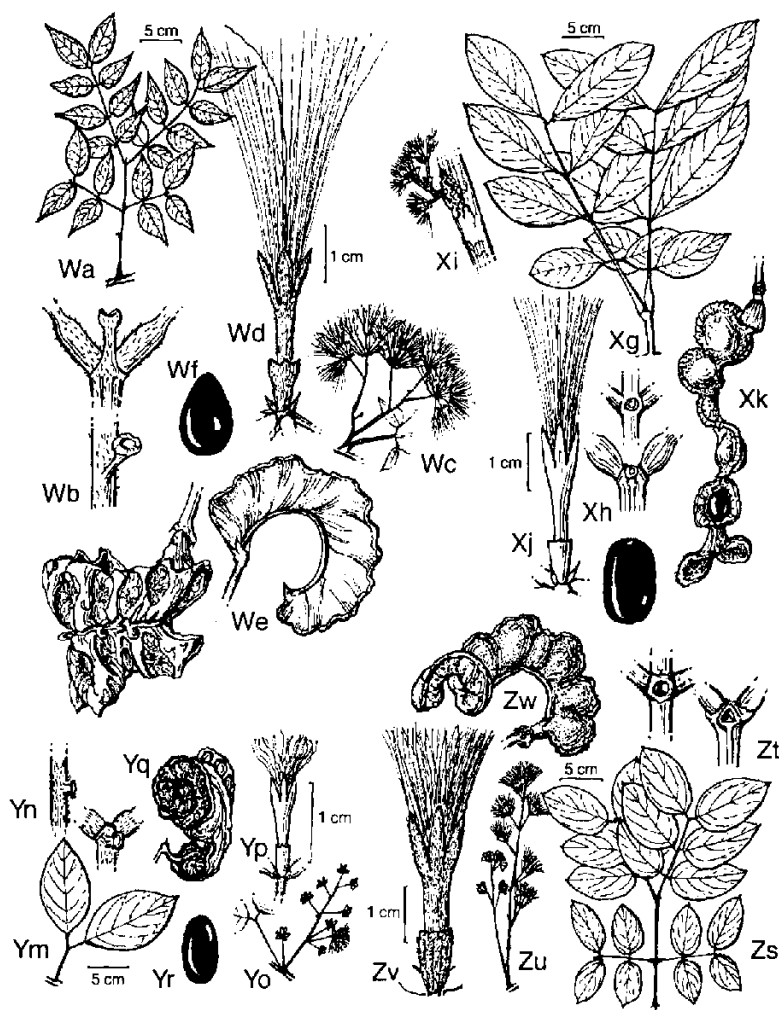


Figure 6

Sketches by Milton Andrews

W *Archidendron grandiflorum*, **Wa** a bipinnate leaf; **Wb** a stalked nectary on the leaf axis; **Wc** flower head the individual flowers as in **Wd**; **We** and **Wf** pods, one open, containing seed **Wf**.

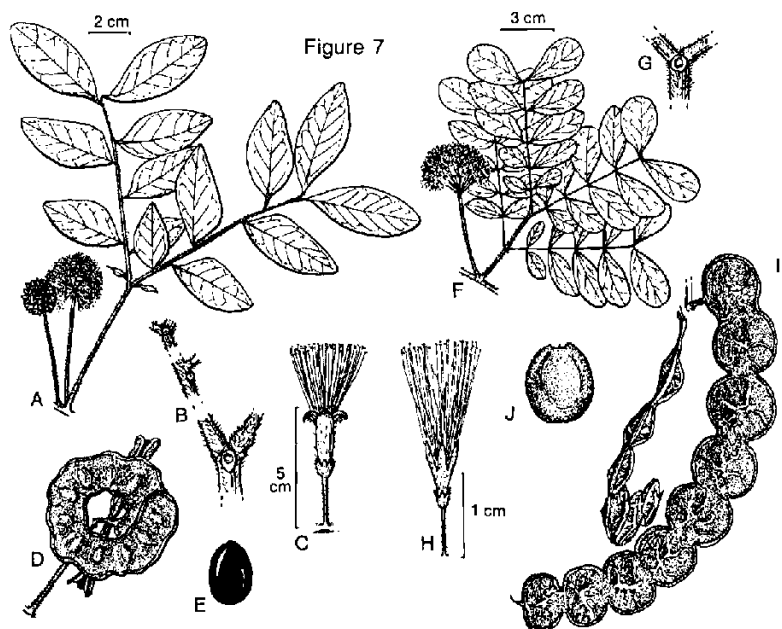
X *Archidendron ramiflorum*, **Xg** large leaves; **Xh** nectaries on the leaf stalk; **Xi** white flowers on the tree trunk each flower as in **Xj**; the pod **Xk** has a characteristic shape with seed **Xi**.

Y *Archidendron whitei*, **Ym** a leaf with one pair of leaflets, the nectaries **Yn** where leaflets join; **Yo** the flower raceme of individual flowers **Yp**; **Yq** seed pod and seed **Yr**.

Z *Archidendron vaillantii*, **Zs** the leaf with pairs of leaflets in pairs with the nectary **Zt** at axis; **Zu** the individual flowers **Zv** are clustered as in **Zu**; **Zw** the seed pod.

Pararchidendron pruinosa 'Raintree' or 'Tulip Siris', (photograph on page 65) figure 7A-E (previously known as *Pithecellobium*) is a spreading tree 3-20 m tall with attractive fragrant cream to white flowers that attract honey-eaters. It is a hardy tree which, given good conditions and plenty of water, can make an excellent shade tree. In most garden situations, however, it only develops into a small tree. If it does not get any water during long dry periods it will become deciduous. It is suitable for planting in full sun as far south as northern NSW. Figure 7A shows a node with leaf (leaflets in 6-12 pairs, 3-8 cm long, 1-4 cm wide) and flower head comprised of many individual creamy white fragrant flowers C. B shows the leaf axils and nectaries; D the pod and E the seed.

Cathormion umbellatum, (photograph on page 65) figure 7F-J, is a shrub or small multi-stemmed spreading deciduous tree 4-7 m tall from coastal or near-coastal areas across the north. It has rough, dark grey bark, fissured to somewhat flaky. The leaves are in 3-7 pairs (1-5 cm long, 1-5 cm wide) as in F glossy dark green above, pale beneath. Flowers are cream to cream-green with many stamens as in H, sweet scented 1.5-2 cm long in hands 4-5 cm across as in F. Pods I are non splitting but breaking into one seeded sections, dark grey to black. Hardy dense shade or screen tree.



Boab — The Boab Tree

by Pat Lowe, Publisher Lothian Books

The Australian species, *Adansonia gregori* is clearly related to the other species of *Adansonia* of Madagascar. Carbon dating of a specimen felled there in 1960 gave an age of 1,000 years. The oldest of our Boabs could be this old but they are certainly very old trees indeed, bearing the marks of very old visitors to this continent. Young or old they are certainly magnificent trees standing stark and often alone in our harsh dry north-western tip of Australia, laden with rich green foliage in the wet season, bare with twisted fingered branches during the torrid dry period. Pat Lowe has written a whole book on the various features of this tree, its history, its uses, its legends. Available for \$34.95 from your bookseller. Other commercial uses given on page 83.

Eucalyptus cinerea

studies of its lignotuber

by Alison Graham, Meredith Wallwork and Margaret Sedgley*

The genus *Eucalyptus* consists of over 500 different species, of which less than half a dozen are not endemic to Australia. Some of these Australian native species have been targeted as having considerable potential in the area of plantation forestry, and are being increasingly grown around the world for both the pulp and hardwood industries. In addition, the use of eucalypts for cut flowers and foliage is increasing world-wide, creating another area of high export potential for Australia's growers.

Various structures produce new leafy shoots following a defoliation event: naked buds and accessory buds from the axillary meristem and lignotuber (figures 2 and 3). Naked buds, also known as primary or axillary buds, are the growing points which develop in the axils of every eucalypt leaf before it unfolds. In most cases there is only one naked bud per axillary meristem, but occasionally as many as three have been reported. These naked buds are capable of growing out quickly into lateral shoots following defoliation by fire, drought or animal attack, and the density of the eucalypt crown is thus maintained. If they do not grow out into shoots these buds are quickly shed, and the line of dehiscence leaves a conspicuous scar in the leaf axil.

Accessory buds, which are variously known as "concealed", "proventitious", "dormant" or "epicormic" buds in the literature, are primarily responsible for the extensive regenerative ability of the eucalypts. These buds are located below (abaxial to) the naked buds in the axillary meristem, and remain dormant and invisible so long as the naked buds are present and growth is uninterrupted. If both the naked buds and young leaves are removed during a growing season however, they will be rapidly replaced by epicormic shoots from these accessory buds. If these epicormic shoots are also removed, new accessory buds will form between them and the leaf petiole, and this replacement process may be repeated several times in one growing season. In addition, as a tree ages the accessory buds will proliferate, so that clusters of epicormic shoots are formed to refoliate the plant after defoliation. It has been shown that accessory buds are not derived from naked buds, but instead both types of buds originate from a single persistent axillary meristem. Practically all *Eucalyptus* buds originate from this meristem, and if it is removed, no further buds are formed. It has been found that accessory buds are subject to continual change; that is, they grow, die and are replaced by new ones at the same axillary site. The *Eucalyptus* lignotuber is also a source of dormant buds which allow the regeneration of trees after a defoliation event.

In this study, cotyledonary node lignotuber development, the origin, arrangement and development of lignotuber accessory buds and patterns of shoot growth and development from the *Eucalyptus cinerea* lignotuber were investigated both naturally and in response to a single pruning treatment.

* Research is being undertaken at the Department of Horticulture, Viticulture and Oenology, Waite Agricultural Research Institute, University of Adelaide, Glen Osmond, South Australia 5064, Australia. It is part of an ongoing study into the commercial development of *Eucalyptus*. *Eucalyptus cinerea* is used commercially for foliage harvesting. Other commercial uses of *Eucalyptus* are given on page 83.

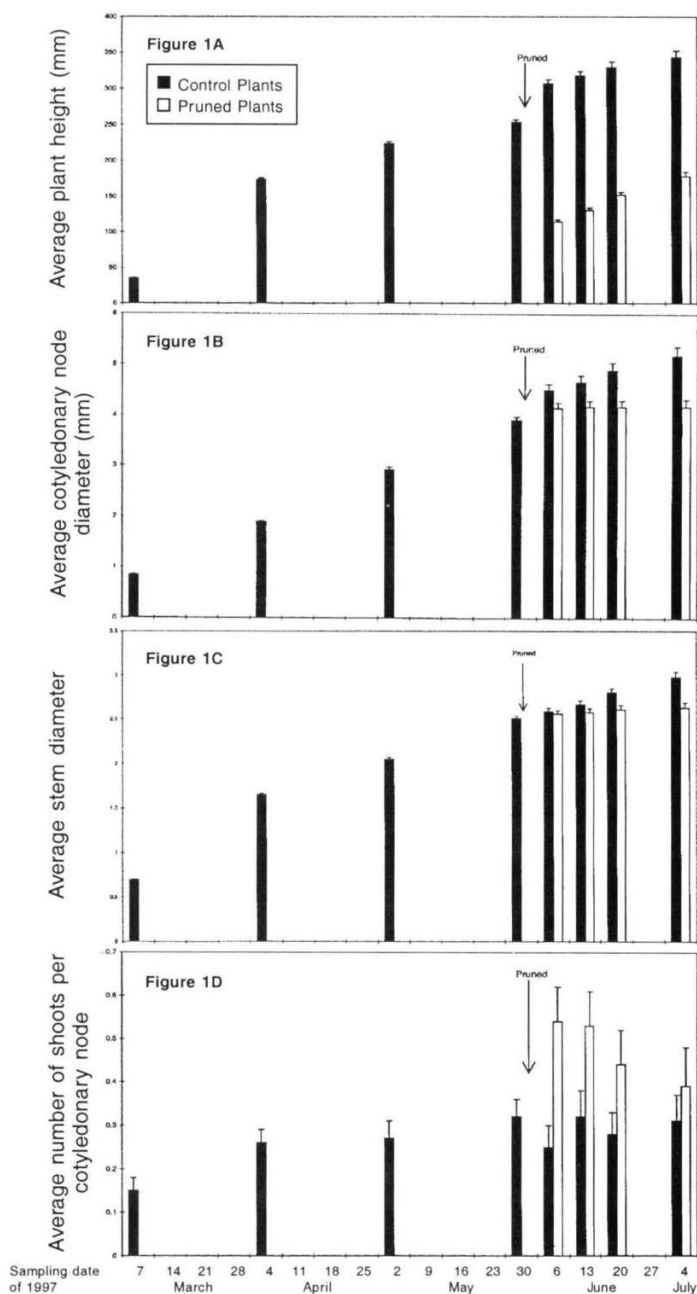


Figure 1. A study of *Eucalyptus cinerea* seedlings over the sampling period, 7 March–4 July. Figure 1A. **Average plant height** of control and pruned seedlings, see opposite for treatment. Figure 1B. **The average cotyledonary node diameter** of the control and pruned seedlings. Figure 1C. **The average stem diameter** of control and pruned seedlings over the period. Figure 1D. **The average number of shoots** arising from the cotyledonary nodes of seedlings.

Experimental details

Twenty-five grams of *Eucalyptus cinerea* seed, supplied by Nindethana Seed Service (Woogenilup, Western Australia), was sown in seed raising trays, and set to germinate in a greenhouse held at 25–30°C. Three weeks after sowing, when the first pair of true leaves had unfolded, 300 seedlings were pricked out and transplanted into 10 cm plastic pots containing 500 mm³ of a University of California mix consisting of coarse sand and peatmoss in a 4:3 ratio, supplemented with calcium hydroxide (1000 gm/1000 L), calcium carbonate (686 gm/1000 L) and Nitrophoska (15–4–12) fertilizer (857 gm/1000 L).

Fifteen weeks after sowing, all seedlings were repotted into 12.5 cm plastic pots containing 900 mm³ of a potting medium formulated for Australian native plants. This consisted of composted pine bark and coarse white sand in a 2:1 ratio, supplemented with iron sulphate (800 gm/1000 L), dolomite (1000 gm/1000 L), calcium carbonate (500 gm/1000 L), gypsum (500 gm/1000 L) and iow P Osmocote® (3000 gm/1000 L).

The treatment, pruning (+ or –), was randomly allocated. The control was no pruning, while pruning involved one application to remove all of the main and lateral stems above node 4. Pruning was carried out when the seedlings were 17 weeks of age, and was accomplished with the aid of a surgical scalpel.

Tissue samples collected from the cotyledonary node and developing lignotuber of the *Eucalyptus cinerea* seedlings were observed under a microscope. Figure 1 records the results: **plant height**, figure 1A (Plant height was measured using the cotyledonary node as a reference point, using the cotyledons, abscission scar or lignotuber as a guide); **cotyledonary node (lignotuber) diameter** figure 1B (Cotyledonary node diameter was recorded at the widest point); **stem diameter**; adjacent to the cotyledonary node, figure 1C (stem diameter adjacent to the cotyledonary node was recorded below the node, midway between the soil and the cotyledonary node); and the **number of shoots** from the cotyledonary node, figure 1D; the sampling period at an age of 5, 9, 13, 17, 18, 19, 20 and 22 weeks. The length of the shoots arising from the cotyledonary node was measured at 22 weeks. Cotyledonary node and stem diameter measurements were recorded with the aid of a Mitutoyo Digimatic series 500 calliper. Means and standard errors were calculated from 10 replicates.

Three hundred individual plants were sampled at the first observation on 7 March, 288 on 4 April, 276 on 2 May and 263 on 30 May. The difference represents the seedlings sacrificed for microscopy. One hundred and twenty plants from each of the control and pruned treatments were sampled on 6 June, 110 on 13 June, 90 on 20 June and 70 on 4 July.

Results The accessory buds were located primarily within the parenchyma tissue of the lignotuber cortex. Some accessory buds were found within the secondary xylem and phloem tissues of the lignotuber. These deeper buds were always surrounded by a strand of parenchyma tissue, which arose from a central point within the lignotuber, close to the seedling stem xylem. This central point contained a large, central bud in two of the three cotyledonary axils examined (figure 4), which was the naked bud of the axil prior to lignotuber development. Lignotuber growth had engulfed the naked bud, leaving it surrounded by a region of parenchyma cells within the lignotuber xylem. Strands of parenchyma tissue radiated out from this central point in all directions, and terminated in the cambial zone. It was within these strands of parenchyma that several accessory buds were initiated.

One of the cotyledonary axils examined did not have this central (naked) bud present within the lignotuber, but strands of parenchyma tissue radiated out from a central point, close to the stem xylem. The central (naked) bud of the lignotuber was located in approximately the middle of the lignotuber hemisphere. Accessory buds were both within the cortex and within the parenchyma strands, within a 60° arc of this central area, both above and below the central bud, and to either side of it. One of the lignotubers examined from the control seedlings harvested at 22 weeks of age contained a region of meristematic cells which had not yet differentiated into accessory buds. This region of undifferentiated meristematic tissue was within a strand of parenchyma tissue, which was located within the secondary xylem of the lignotuber.

An average of 17.3 accessory buds was observed within the cotyledonary axils of the seedlings which had been pruned at 17 weeks of age, compared with an average of 9 accessory buds per cotyledonary axil of the control seedlings.

Seedling growth over the experimental period is presented in figure 1, which illustrates plant height development patterns for control seedlings between 5 and 22 weeks of age, based on measurements recorded on eight sampling dates. Seedling growth of the pruned seedlings aged between 18 and 22 weeks is also illustrated in figure 1, corresponding to the first 5 weeks after pruning and recorded on four sampling dates.

Cotyledonary node diameter of the control seedlings increased over the experimental period from an average of 0.8 ± 0.01 mm at 5 weeks of age to an average of 5.2 ± 0.2 mm at 22 weeks of age (figure 1B). This increase in diameter of the cotyledonary node illustrates the development of the two lobes of the lignotuber, the swellings of which were generally observed in paired (decussate) fashion at the cotyledonary node from 9 weeks of age.

Stem diameter of the control seedlings increased over the experimental period from an average of 0.7 ± 0.01 mm at 5 weeks of age to an average of 3.0 ± 0.1 mm at 22 weeks of age (figure 6). As with the cotyledonary node diameter, increases in stem diameter of the pruned seedlings did not keep pace with that of the control seedlings.

Number of shoots arising from the cotyledonary node was significantly greater in the pruned seedlings than in the control seedlings in the week following pruning. This difference was also found when the seedlings were observed two weeks after pruning. However, no differences in shoot number were found between the control and pruned seedlings when observed 3 and 5 weeks after pruning. At 22 weeks of age control seedlings had an average of 0.31 ± 0.06 shoots arising from the cotyledonary node while treatment seedlings had an average of 0.39 ± 0.09 shoots (figure 7).

Most of the single shoots growing from the lignotuberous swellings emerged through the central lower half of the swelling, and, as a result, grew downwards initially before turning up. Seedlings that had two shoots arising from the same lignotuber swelling generally produced the second shoot directly above the first.

Lignotuber development of *Eucalyptus cinerea* follows the following pattern. The lignotuber swellings first appear above the naked bud in each cotyledonary axil, while the accessory buds remain deep-seated in the cleft. The swellings then bulge outwards and subsequently descend, engulfing stem tissue and nodal tissue, in addition to all buds which are still present within the cotyledonary axil.

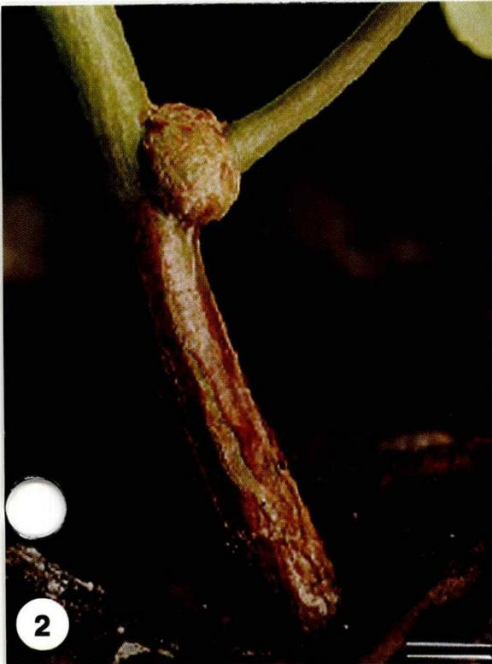
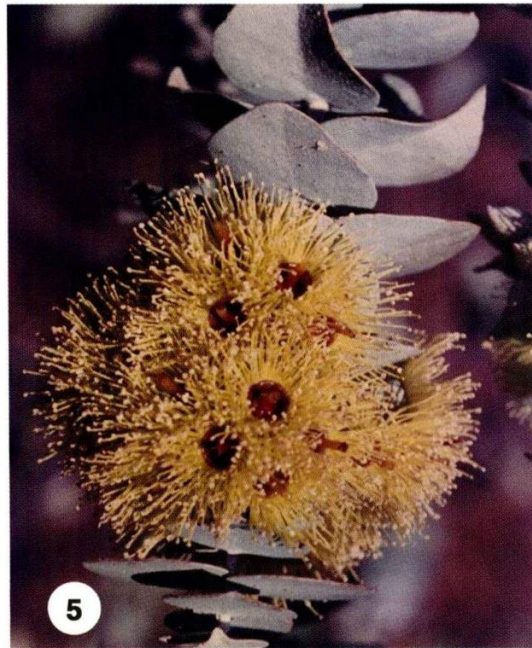


Figure 2. **Cotyledonary node lignotuber** of a *Eucalyptus cinerea* control seedling at 22 weeks of age showing a single shoot arising from the swelling. Bar represents 5 mm.

Figure 3. **Cotyledonary node lignotuber** of a *Eucalyptus cinerea* pruned seedling at 22 weeks of age, showing two shoots arising from the one swelling. Bar represents 5 mm.

Figure 4. **Microscope view** of one half of a 20 week **lignotuber** from a seedling pruned at 17 weeks. The central naked bud is visible. Photographic work by Jennie Groom

Figure 5. *Eucalyptus* species with round grey leaves much sought after in flower arrangements, one cultivar is even called 'Silver Dollar'. The foliage is worth more than the flowers.



It has been claimed that this downward growth continues throughout the life of a lignotuber, as it folds itself down the stem and envelops the upper part of the root. The lower part of a lignotuber is therefore really the younger. This downward growth pattern may explain why most of the shoots developing from the lignotubers in the study were found to arise from the lower half of the lignotuber swellings — these shoots were found to grow downward initially, before turning up.

Some *Eucalyptus cinerea* seedlings in this study were found to have produced lignotuberous swellings at the first node by 22 weeks of age, with or without having produced a lignotuber at the cotyledonary node. Macroscopic observation indicated that lignotuber growth and development at this node followed the same pattern as that described for the cotyledonary node lignotubers. In addition, this study has supported previous observations concerning exfoliation of the lignotuber cortex. It has been suggested that the sudden expansion of the lignotuber outstrips the capacity of the cortical stem tissues to cover it, resulting in the cortex breaking up in flakes. This is then replaced by tissues derived from the activity of a precociously developed cork cambium. This exfoliation and cork development was clearly seen in the macroscopic observations of the *Eucalyptus cinerea* lignotubers in this investigation.

Lignotuber anatomy and morphology has been clarified by this research. Accessory buds within the *Eucalyptus cinerea* lignotuber have been found to arise adventitiously, both within the lignotuber cortex and within strands of parenchyma tissue radiating from the lignotuber centre. It was shown that these buds increase in number following a pruning treatment, but it is not clear what factors are involved in establishing the buds in their random locations, particularly those throughout the cortical tissue. This issue requires clarification in future studies, as this information would benefit those involved in the production of juvenile *Eucalyptus* foliage by lignotuber stimulation, including foliage cultivators and tree propagators.

Lignotuber development patterns observed in this study have shown that the original naked bud of each cotyledonary axil often becomes engulfed by woody tissue during lignotuber growth and expansion. The naked bud thus becomes situated in the centre of the young lignotuber swelling, close to the seedling stem xylem. This can be seen to be a well protected position for this dormant bud, and possibly provides the seedling with an extra opportunity for refooliation following a severe defoliation event, such as fire.

Pruning was found to increase the number of shoots arising from the cotyledonary nodes of *Eucalyptus cinerea* seedlings, but the mechanism of apical dominance appeared to prevent these shoots from further development, and many abscised soon after initiation. Continual coppicing, such as that practiced by cut foliage cultivators, is therefore required to remove the inhibition imposed by apical dominance, and thus allow these lateral shoots to develop from the lignotuber. Further research is recommended to clarify the location and timing of these pruning cuts required to overcome apical dominance, in order to maximize the number of shoots that can be produced from each lignotuber at any one time. It is also recommended that this research involve a range of *Eucalyptus* species, since Australia has an abundant reservoir of *Eucalyptus* species which remain largely untapped for the world cut foliage market. The production of juvenile foliage from these species would allow us to increase our production of *Eucalyptus* foliage for the cut flower market, with the potential to earn export dollars for the Australian community.

Ornamental eucalypts

Commercial prospects for our Eucalypts

by W. H. Payne

The use of eucalypt trees in landscaping is worldwide especially for ecological reasons. Carbon sink/carbon credits for atmospheric pollution compensation is the latest political game so why not get in on the act. We are depending on trees to suck up water and lower the water table and deter salination of our productive farming lands. This is a "thumb in the dyke" approach as the salt mass below ground is continuing to build up ready to engulf us. We need to continue to plant more and more trees but why not start removing the salt as well.

Eucalyptus oil production can be a valuable by-product of a salination control. Above 600 mm rainfall the Tasmanian Bluegum is being exploited. Below 400 mm, down to 250 mm of rainfall those suitable for the production of eucalypt oil: *Eucalyptus polybractea*, *E. horistes*, *E. kochii*, *E. loxophleba* and *E. angustissima*. Management is by coppicing, these species regenerating from the stump every second year. They do not build up a big pool of carbon in the above ground parts but the extensive root system ties up a lot of carbon underground.

The use of eucalypt foliage in cut flower arrangements has become a world wide income bonanza but what of the flowers. This report from Kate Delapoite.

"To develop eucalypts for ornamental horticulture and to breed new and interesting plants by taking the big flowered species and crossing them with small flowered species with the aim of getting an intermediate marketable size. The more decorative species of eucalypts are involved in a planting trial. Twenty plants each of the following 9 species, selected for their large flowers and attractive buds and fruits have been planted: *Eucalyptus anceps*, *E. erythrocorys*, *E. forrestiana*, *E. leptophylla*, *E. lesouefii*, *E. stoatei*, *E. uncinata*, *E. yalataensis* and *E. youngiana*. The study is being carefully monitored.

Eucalypt flowers have a tendency to drop their stamens so we are looking for a way to stop the stamens from falling off and making a mess. This study is also concerned with buds and fruits for harvest and whether the flowers open after harvest and how long they keep on opening up. Continual opening after harvest and maximum vase life are qualities that are vital in creating a viable commercial product."

Propagation is a major problem to researchers in the development of out eucalypts as vegetative propagation of selected and developed clones is essential. The traditional way to produce plants has been from seed but this surrenders control over selection of desirable species. The paper pulp industry has overcome this by propagation from cuttings using fresh shoots from the root tubers or coppiced growth. The article on page 77 is of far greater importance than it first appears. It shows that Professor Margaret Sedgley is now turning her attention to the development of commercial eucalypts. She advises:

"We now have good cutting propagation methods for the Waite cultivars but the cuttings have to be large for optimum success. For this reason we have studied tissue culture as an alternative. Kim Tynan studied this, and Eileen Scott was co-supervisor of the work. Kim achieved successful establishment, multiplication and rooting of plantlets in culture, but was not able to harden them off so they could exist outside the culture tube. This work is continuing."

Diseases of native plants

Report by Brett Summerill on studies at Royal Botanic Gardens, Sydney

Flannel flower wilt. These studies were reported in detail in Australasian Plant Pathology, 1997 and 1998. The flannel flower, *Actinotus helianthi*, shows considerable promise as a cut flower and as a potted plant. A large number of plants propagated for commercial use wilt and die. A study has found that the cause was a fungus, *Fusarium oxysporum*. The roots of the affected plants were healthy and the seed used did not carry the disease. The source of the disease was not determined despite rigorous clinical procedures. This fungus can also affect other members of the family Apiaceae such as celery and parsley.

Sturts Desert Pea, *Swainsona formosa*, suffers wilting, yellowing, stunting of foliage and death, especially in periods of high humidity. It is a major problem when preparing young plants for sale. A rot extends from the base of the plant upwards for 5–8 cm with a grey fungal sporulation typical of a species of *Botrytis* covering the area. A study showed this to be the fungus *Botrytis cinerea* and is likely to be a major constraint to the cultivation of Sturts Desert Pea. Protective fungicides will be needed for commercial production.

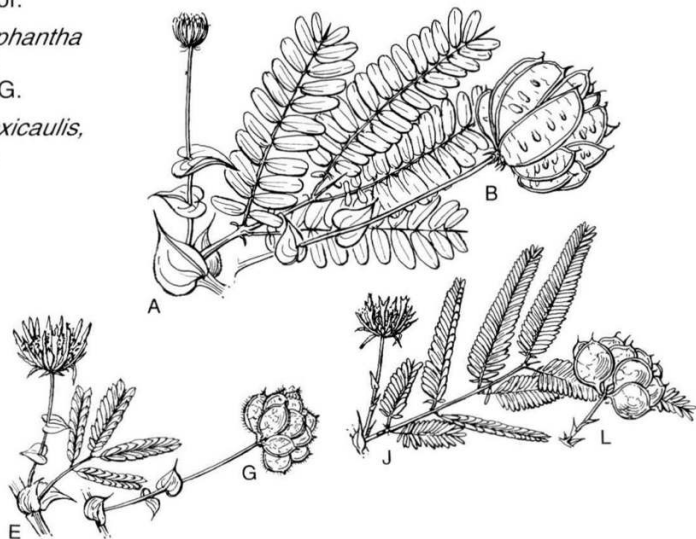
Everlastings of the *Helichrysum/Bracteantha* Group have been developed commercially for use as bedding annuals. Diseased specimens were observed and collected for study. Symptoms included, wilting, stunting and subsequent death. Root systems of diseased plants were often necrotic and stunted. A study showed that the fungus *Fusarium oxysporum* was primarily responsible.

Terrestrial or aquatic herbs Plant family Mimosaceae, continued from page 66.

Legumes for the pool or terrarium. Will readers with terrariums please contact the Editor.

Neptunia dimorphantha
as in E with the
fruiting head in G.

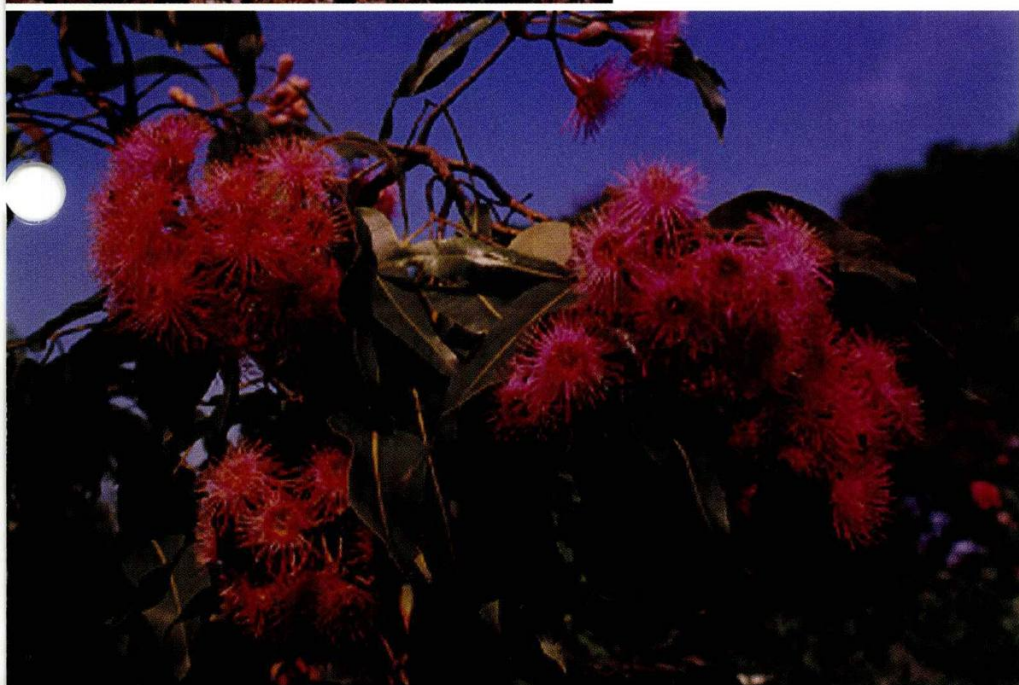
Neptunia amplexicaulis,
as in A with the
fruiting head
enlarged in B.





Eucalyptus ptychocarpa

growing in Jack Hayward's garden in Sydney. The tree is at its mature height, the flowers are real. We hope that the research reported in this issue will allow us to grow the western mallees that flower equally as spectacularly at a similar mature height.



Sydney Flora — A Beginners Guide

by Tony Edwards and Joan Webb

This 156 page pocketbook (11 x 22 cm) has been produced by lecturers at a TAFE college and is clearly aimed at students in a course of study of the wildflowers of the Sydney area. For this reason it is easy to read and digest the information presented, to learn the basics of botany and how to identify plants on a bush ramble. There are colour photographs and many clear, easy to follow sketches. Available for \$20.00.

Native Plants of Sydney, A Field Guide

by Les Robinson

This revised second edition of 448 pages is an exceptional production. Over 1,370 species are described and illustrated. For all species there are sketches illustrating the features of the plant, leaf and flower. There is an illustrated key to enable the reader to go to a group of plants but most bush walkers of the Sydney area will not need it. They can readily go to the page necessary and there you will find sketches of all similar species and a visual indication of how they differ. **Easy identification** is on the cover and it certainly is. Excellent value at \$24.95.

Wildflower Nurseries in Queensland

Fairhill Plants and Botanic Gardens — Huge range; rainforest plants, grafted grevilleas, rare plants, wildflowers, ferns, orchids, revegetation trees. Extensive display gardens. Open every day 8.30 a.m.—5.00 p.m. Fairhill Native Plants, Fairhill Rd, Yandina, Qld 4561. Tel. (07) 5446 7088.

Nielsen's Native Nursery — Over 500 species including grafted grevilleas, eremophilas, eucalypts and brachychitons, also Foxtail Palms, cycads, rainforest, Bush Tucker plants. Display garden. Open 8.00 a.m. to 5.00 p.m. every day. 49–51 Beenleigh Redland Bay Rd, Loganholme, Qld 4219. Tel. (07) 3806 1414.

Wildflower Nurseries in New South Wales

Annangrove Grevilleas — 98 Annangrove Rd, Kenthurst 2156. Tel. (02) 9654 1380. Wide range of natives including hundreds of different species in tubes — many hard to get. Ten percent discount to SGAP members.

Bryants Native Plant Nursery — Cosy Camp Rd, Bex Hill, N.S.W. 2480. Tel. (02) 6628 4323. 15 kms north of Lismore. Open 7 days (from 11 a.m. on Sundays). Extensive range. Excellent quality and service.

Dealbata (cold climate) Aust. Plant Nursery — off Bloomfield St, Dalgely 2630. Tel. (02) 6456 5043. Specializing in alpine and dry Monaro plants — grown from locally collected material. Phone to arrange visit.

Illawambra Native Growers — P.O. Box 89, Cobargo, N.S.W. 2550. Tel. (02) 6493 7398, mail order specialist. Send 2 x 45¢ stamps for catalogue of our large range including rare species.

Newcastle Wildflower Nursery — 260 Lake Rd, Glendale 2285. Tel. (02) 4954 5584. Extensive range of native plants including rare and endangered species.

Sydney Wildflower Nurseries — South at Heathcote (02) 9548 2818; West at Marsden Park (02) 9628 4448; North at Terrey Hills (02) 9450-1555. Excellent range of native plants. Open 7 days.

Wirrimbirra Native Nursery — Hume Hwy, between Bargo and Tahmoor E. side 2574 (3 km from Freeway entry). Wide range including unusual plants. Tel. (02) 4684 1112.

Wirreanda Nursery — End of Wirreanda Rd, Ingleside 2101. Tel. (02) 9450 1400. Growers of advanced and semi-advanced native trees and shrubs. Open 7 days.

Wildflower Nurseries in South Australia

Brenton Tucker Native Plants and Carawatha Garden — Placid Estates Rd, Wellington East via Tailem Bend. Tel. (08) 8572 7104. Wide range of tubestock and advanced plants. Extensive display gardens and picnic areas. Open weekends and public holidays March to November and by appointment — 10 a.m.—4 p.m.

Wildflower Nurseries in Tasmania

Plants of Tasmania Nursery — 65 Hall St, Ridgeway 7054. SAE catalogue. Tel. (03) 6239 1583. Open 7 days.

Wildflower Nurseries in Victoria

Kuranga Native Nursery — Australia's largest range of Australian plants. Delivery Australia-wide. Free stocklist on request. The Kuranga Handbook of Australian Plants now available RRP \$19.95. A comprehensive guide on plants stocked at Kuranga. 393 Maroonah Highway, Ringwood 3134. Tel. (03) 9879 4076. Open 7 days.

Australian Wildflower Seed Suppliers

R. Horner — 1 Grundy St, Alice Springs, N.T. 0870. Seed of trees and shrubs of Central Australia. Please send 45¢ stamp for a list.

Wildflower Society of Western Australia (Inc.) — P.O. Box 64, Nedlands 6009. A range of seeds available, labelled and packed, at \$1.00 (plus postage) per packet. Send for a 1997/98 Descriptive Seed List (\$1.95 posted) to: The Seed Sales Officer, Eastern Hills Branch, 65 Swan View Road, Swan View, WA 6056. Also available a book "Hints on Growing Native Plants" \$4.00 posted.

Correction, apologies! To Kathylyn Humphrey for the poor printing job on the rear cover of our last issue; appropriate action has been taken. To Don and Jeanette Closs for calling Don Gordon on page 361 of the No. 156 issue; there is no excuse for this terrible error. Also in that issue the incorrect crediting of artistic sketching of page 379 to D. Boyce instead of D. Boyer. Diana has forgiven me to the extent that she will be doing sketches for us in future issues. Editor.

The Australian Flora Foundation

President: Dr Richard Williams, Gatton Campas, University of Queensland. Dr M. L. Reed will continue as Secretary, G.P.O. Box, Sydney 2001. Give to research into the biology and cultivation of the Australian flora. Tax deductible donations and bequests go to research projects carefully chosen and vetted by a committee of scientists.

Australian Plants received by membership or subscription

Membership: Contact the secretary, listed below, of your state of residence.

Annual subscription: \$18.00 (A\$30.00 overseas) including postage to your address.

Binders: Ring binders to fit the holes drilled, available for \$6 plus 90c postage.

Past issues: Recently published issues are \$4 plus 90c postage.

Australian Plant Reference, an index for all volumes 1–18, \$15 + \$5 postage.

Bound volumes: Past issues available only in bound volumes, \$45 + \$6 postage.

Want back issues of this periodical? Giving a present? The best way is to own the past issues fully bound with a quality spine that sits proudly on a bookshelf. Volume 18 has a bonus, it includes the Australian Plant Reference alone valued at \$15. Volume 19 is now available.

Discount book service: Each state society listed below has a mail order book supply service, usually at discount prices. Contact the secretary listed below for your requirements.

The Societies for Growing Australian Plants

AUSTRALIAN PLANTS SOCIETY:

President: Mrs Val Williams, 51 Yaralla Crescent, Thornleigh, NSW 2120.

Secretary: Mr Rolf Cambridge, P.O. Box 744, Blacktown, NSW 2148.

Office — Tel. (02) 9621 3437. Fax. (02) 9676 7603. E-mail: austplantsocadmin@nectar.com.au

THE SOCIETY FOR GROWING AUSTRALIAN PLANTS — CANBERRA REGION INC.:

President: Ms Gwyn Clarke, 26 Henry Street, Cook, ACT 2614.

Secretary: Ms Rosemary Blemings, P.O. Box 217, Civic Square, ACT 2608.

THE SOCIETY FOR GROWING AUSTRALIAN PLANTS — QUEENSLAND REGION INC.:

President: Mr Geoff Goadby, P.O. Box 586, Fortitude Valley, Qld 4006.

Secretary: Mr Ian Waldron, P.O. Box 586, Fortitude Valley, Qld 4006.

THE SOCIETY FOR GROWING AUSTRALIAN PLANTS — SOUTH AUSTRALIAN REGION:

President: Mr Jeff Reid, 13 Carlsson Place, Hope Valley, SA 5090.

Secretary: Mr Mick Freeborn, 5 Marram Terrace, Largs North, SA 5016.

THE SOCIETY FOR GROWING AUSTRALIAN PLANTS — TASMANIAN REGION INC.:

President: Ms Sue Gray, G.P.O. Box 1353P, Hobart, Tas. 7001.

Secretary: Ms Jill Roberts, G.P.O. Box 1353P, Hobart, Tas. 7001.

THE SOCIETY FOR GROWING AUSTRALIAN PLANTS — VICTORIA INC.:

President: Mrs Nicky Rose, 13 Karabil Crescent, Scoresby, Vic. 3179.

Secretary: Mr John Walter, 11 Davies Street, Bacchus Marsh, Vic. 3340.

WILDFLOWER SOCIETY OF WESTERN AUSTRALIA INC.:

President: Mr Brian Moyle, P.O. Box 64, Nedlands, WA 6009.

Secretary: Mrs Barbara Dewar, P.O. Box 64, Nedlands, WA 6009.

Office open Tuesday/Thursday — Tel. (08) 9383 7979 (24 hr answering service).

ASSOCIATION OF SOCIETIES FOR GROWING AUSTRALIAN PLANTS INC.:

President: Mrs Wendy Fopp.

Secretary: Mrs Eileen Crooks, 39 King George Avenue, North Brighton, SA 5048.

PUBLISHED BY THE SOCIETY FOR GROWING AUSTRALIAN PLANTS — NSW LIMITED

Under the direction of the PUBLISHING COMMITTEE — Editor: W. H. Payne.

Assisted by: P. D. Leak, B. Maloney, N. Scarborough, R. Smythe Kirk and P. Bailey.

Editorial Material: Editor, Australian Plants, 860 Henry Lawson Dr., Picnic Point 2213. Enquiries by mail only.

PUBLISHING COMMITTEE: D. G. Brooks (Chairman), Ms J. Caldwell, Dr R. Daniels, P. Lane, W. H. Payne, R. Smyth-Kirk, H. Stacy, B. Walters, Mrs V. Williams, P. Davies and M. Robinson corresponding members.

Mail of a non-editorial nature to: SGAP Publishing Committee, P.O. Box 744, Blacktown, NSW 2148.

ALL PUBLISHED MATERIAL IS COPYRIGHT AS DIRECTED BY AUTHORS.



***Banksia* 'Birthday Candles'**

This picture is no fantasy. It is a dwarf form of a *Banksia* normally growing to 2 m tall but here, just a few centimetres. It flowers well just as shown here. See the report on page 50. We owe this treasure and many other excellent garden cultivars to Bill Molyneux of Australfora Nursery, Melbourne.