

Australian Plants



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Where is Australian Plants going? Since the national convention in 1995 there has been an intensive study of our presentation and content. This resulted in an avalanche of support and acclamation for what has been achieved. Comments received reflected matters that have been continually reviewed over the last 20 years. All correspondents will receive a detailed reply. The overall concern is that we continue exactly as we are doing now.

Where is Australia going? This should be a major national concern. The politicians are desperately playing three year vote catch planning and ignoring the catastrophe that confronts us in the year 2000 and beyond. It is easy to be cynical about this but possibly the fault is with ourselves. We are clearly not getting the message past the bureaucratic shield to the politicians in a way they can understand. It is so easy for them to dismiss those who try to advise them as belonging to the "lunatic fringe" of do-gooders. Even a large proportion of the general public are cynical and suspicious of the "greens". Why is it that the politicians always think in terms of megabucks when what we want is an opportunity for the average citizen to contribute to the future health and wealth of our country. Fortunately the scientists and ecologists are well aware of the impending disaster and continue to publish appropriate warnings and blueprints for change. In this issue we present some of our proposals in a management plan for the continent of Australia for adoption as an objective for 2001 and beyond.

The Olympic Games! The Australian flora will comprise the floral tributes in Sydney 2000. The arrangements on our rear cover were taken to Atlanta by a member that went there to study and plan the project. They were presented to officials there to show examples of our flora. At this time Waratah, that will be a feature of our presentations, were not quite ready and these arrangements are no indication of what will be adopted. The background to the photograph is unfortunate but shows the haste of departure on receiving the invitation to go.

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COVER PLATE: The Fire Wheel Tree, *Stenocarpus sinuatus*. A magnificent rainforest tree that can grow to 30 metres high in the forest but can be contained in height as a specimen tree. See page 341 for more details, and page 378 for a plea for grafting.

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Native Honeysuckle

The genus, *Lambertia*

by R. J. Hnatiuk and W. H. Payne*

Lambertia ericifolia, **Erica-leaf Honeysuckle**, is a shrub that may grow to 5 m tall but can be kept to 2 m. The leaves 8–20 mm × 1–1.5 mm are whorled, green, with revolute margins and blunt on the end. The red flowers are usually in heads of 7, each 3–55 mm long and conspicuous as they occur on the ends of branches; endemic to the Stirling Ranges, WA. Sketches page 374, photo page 337.

Lambertia inermis, **Chittick**, is a shrub to small tree to 6 m tall with widely spreading branches. As such they are ideal as a screening or hedging plant especially for semi-protected coastal planting. Regular tip pruning will thicken up the shrub and confine the height. The mid to deep green leaves are 6–24 mm × 3–7 mm, smooth above, densely white or rusty brown/velvety below. The flowers are in heads of 5–7 each to 40 mm long, yellow, pale yellow-orange or orange to scarlet, often darker on the limb and dilated in the middle. Sketches on page 374.

Lambertia orbifolia, **Round-leaf Honeysuckle**, is a shrub 2–3 m tall with opposite, characteristically rounded dull green leaves 15–20 mm diameter. The red flowers, 40–50 mm long, are usually in heads of 4–6 flowers, terminal or axillary on the branch, with peak flowering in summer but with odd flowers at other times. An endangered plant, see page 372 for more details and photograph.

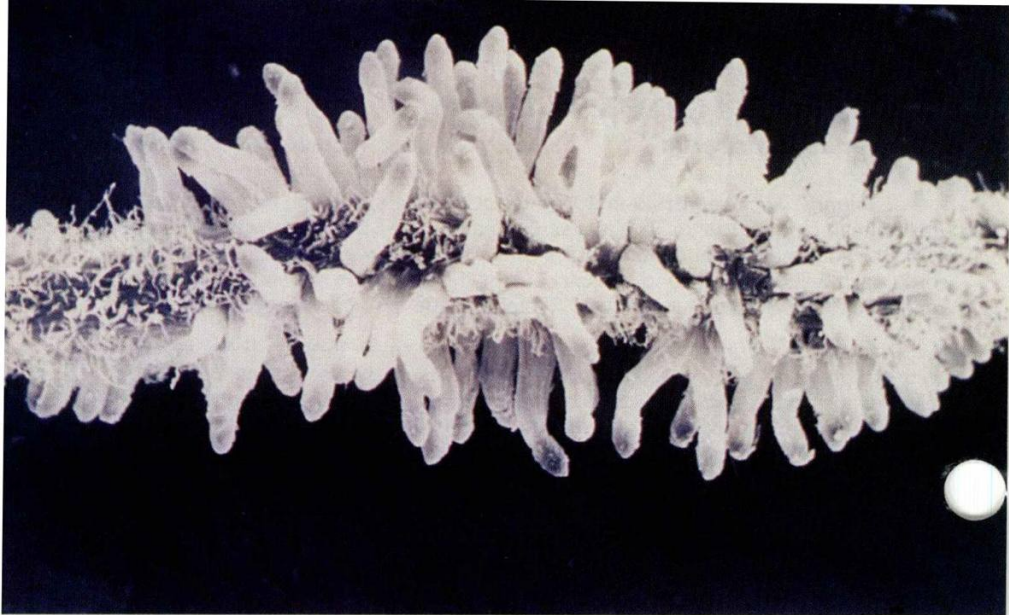
Lambertia ilicifolia, **Holly-leaved Honeysuckle**, is a smaller shrub that may reach 2 m tall but can easily be kept to one metre making a very attractive plant. The thick holly-like leaves are 10–25 mm long, greyish-green, usually curved downward, with pungent spikes on the edges. The bright yellow flowers are usually in heads of 7, often profuse, with terminal and axillary on the branches. It occurs from Quairading, to Kukerin, WA. See sketches on page 371.

Lambertia fairallii, **Fairhalls Honeysuckle**, is a dwarf to small densely branched shrub. Leaves are 20–30 mm × 2–5 mm, dark green above with prominent veins and woolly hairy below, the end finely pointed. The bright yellow flowers are usually in heads of 5–7 flowers each 30–40 mm long and enlarged at the centre; confined to the Stirling Range, WA. Sketches on page 371.

Lambertia echinata, **Prickly Honeysuckle**, is a shrub 2–5 m tall in the wild but can be kept to a small shrub in cultivation. The wedge-shaped leaves are 20–40 mm × 20–30 mm, in whorls of 3 around the branches with pungent points on the end. The yellow or reddish pink flowers are usually in heads of 7 often in profusion. It is endemic to the Albany-Esperance area and is regarded as rare. A species formerly known as *L. propinqua* is now regarded as subspecies *citrina*.

Lambertia rariflora is a shrub to small tree to 7 m tall. The leaves are 20–90 mm × 20–50 mm tapering slightly at the base, pungent-tipped in whorls of 3 around the branches. The single inconspicuous flowers are 25–35 mm long, green or yellow, enlarged in the centre. A rare species from the Busselton area of WA.

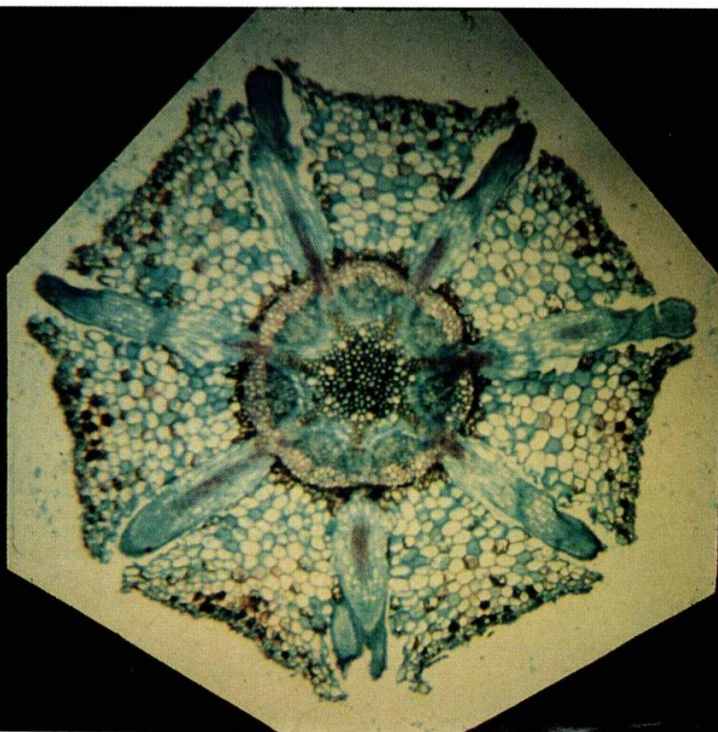
*Based upon *Flora of Australia*, Volume 16, a CSIRO publication. Available as directed inside our rear cover for \$64.95. Permission to use this valuable scientific publication as a source for presentation in a way more easily read by those without a knowledge of botanical terms is appreciated by all. Readers are advised that, with a little perseverance, they can use the original work quite well and they are urged to purchase a copy of each volume in which they are interested, prices on application by mail to the address inside the rear cover.



△ **Proteoid roots.** A scanning electron micrograph of a young proteoid root before root hairs (visible at the margins on the parent root) have developed on the cluster of rootlets. Scale is 1 mm (lengths of 50 mm are more typical).

▽ A stained section through a proteoid root of *Hakea prostrata* before the seven longitudinal rows of rootlets have pushed their way through the outer layers of the parent root. Diameter of section is 2.5 mm.

Proteoid root systems are an important feature of healthy growing Proteaceae such as Waratah and Banksia. They are discussed in more detail on page 345 but from an easily read cultivation/management aspect. The article on page 366 also deals with root management.





△ *Lambertia inermis*
Photography by Ilma Dunn

see page 335 for descriptions

Lambertia ericifolia ▽
Photography by I. R. Dixon



Lambertia uniflora is another solitary flowered species, the flowers 25–40 mm long, red with prominent yellow or yellow-green limb. It is a shrub to 3 m tall often with ascending branches. The leaves are 14–30 × 7–13 mm often crowded around the flowers or in distinct clusters, dull green and flat with the rounded end terminating in a small pungent point, see the sketch opposite.

Lambertia multiflora, **Many-flowered Honeysuckle**, is a shrub that may reach 2 m tall in the wild but is a dwarf to small shrub in cultivation. The leaves in whorls of 3 or 4 are 15–80 mm × 3–7 mm and are stiff, often crowded, a mid-green above and paler below, variable as in Figure 1 C–F. The flowers are usually in heads of 7 cupped by yellowish brown leaf-like bracts, reddish-orange in the type variety or yellow in the variety, each 20–30 mm long, green at the tip and enlarged in the middle; occurs Eneabba south to Busselton, WA. Photo page 357.

Lambertia formosa, **Mount Devil, Honey Flower**, the only species in Eastern Australia. It is a shrub to 2 m tall but it is generally only a metre high with the odd branch climbing higher. The leaves are 10–80 mm × 2–7 mm as in Figure 1–J, usually in whorls of 3, tapering to the base but with a pungent point on the pointed end. The flowers are held in a solitary head of 7 flowers, red to orange red to 5 cm long. Mountain devil is a descriptive term for the horned woody fruit, Figure 1K, that is used in art and craft. It is found in heath and woodland along the coast and nearby ranges of NSW. This beautiful shrub is fully described by Alec Blombery with details of propagation and cultivation, together with a large colour photograph in Volume 13, page 237.

Continued on page 371

Growing Proteaceae, Waratah, *Banksia*, *Lambertia*, etc. W. H. Payne

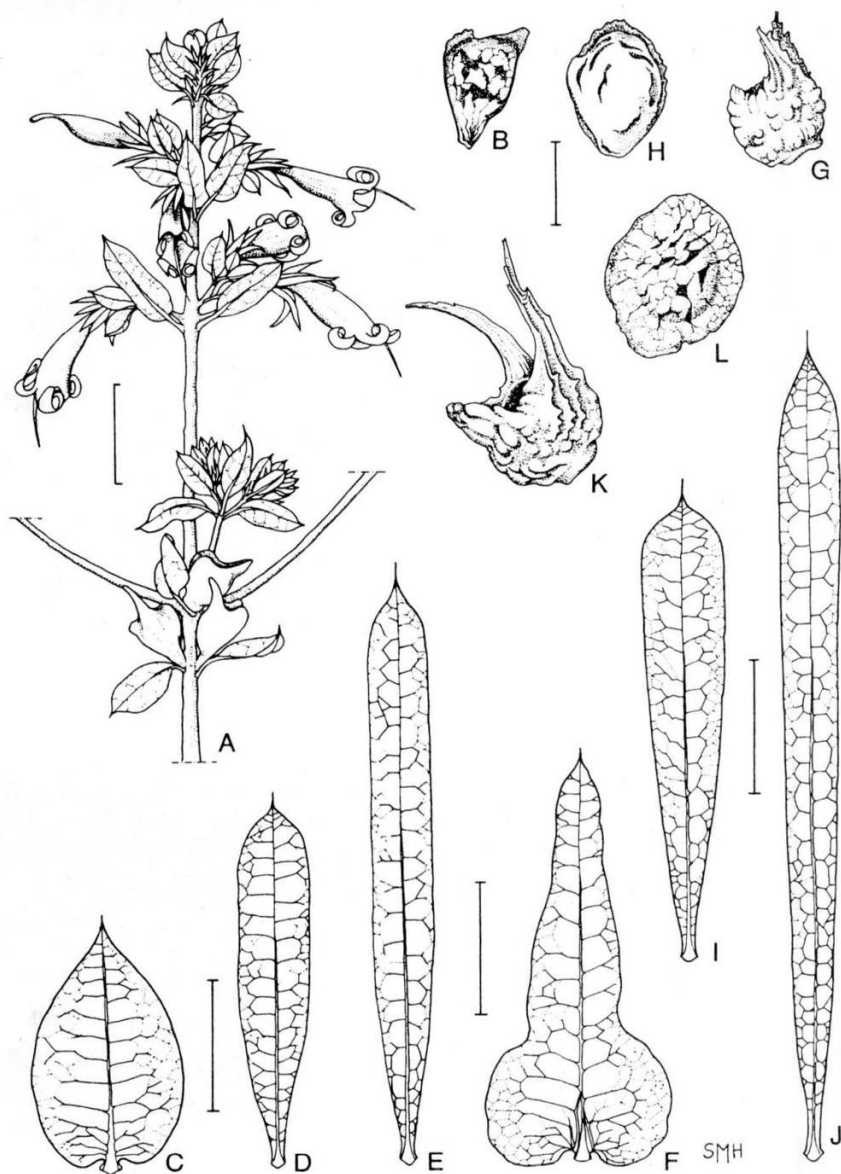
Giving excessive treatment to Waratah? I find that this is an excellent example of cultivation practices for all the beautiful plants in this family. Issues are planned on *Isopogon* and *Petrophile* and the same cultivation practices can apply. The whole practice seems to be shrouded in mystery and, for me, dead plants in the garden. The articles in the last issue seem to contradict each other but all say watch phosphorus and lime. On page 365 they appear to revel in it. In a future issue I expect to have an article explaining this and how it is all a matter of balance. Meanwhile plant only vigorously growing well established plants in deeply drained soil or on mounds, eliminate root competition from trees, fertilise deeply when planting, mulch heavily and water copiously for the first year. See also the beautiful *Banksia* in this issue and the rear cover. Who is growing them?

I especially commend to you the article on proteoid roots in this issue. Do not be deterred by strange words, Byron Lamont has done an excellent job in translating science to the practical level. David Guest deals with the major enemy an root devouring fungus that it also destroying our forests quicker than we are planting them. We have more on this to come with some hope in the future. ■

Growing *Lambertia ericifolia*

by Marilyn Gray, Karwarra Garden, Montrose, Victoria

One specimen planted in 1979 and another planted recently are growing well and flowering. Although, they prefer a sunny position they have adapted well to our semi-shaded conditions and humidity. The profusion of brilliant orange-red tubular flowers occur all year. The flowers, in terminal clusters, are curved and 2–3 cm long. They fade to pale orange with deeper veins. The fragrance seems to be heavier at certain times during the day, stopping you in your tracks to investigate the source. Regular pruning will help to keep this spreading shrub more compact.



Drawn by S. House as in Flora Of Australia, Volume 16

Honeysuckle with leaves that have pungent spines on the end.

Lambertia uniflora A. flowering branch with flowers and fruit, B. seed

Lambertia multiflora, C-F. leaf variation, G. fruit, H. seed

Lambertia formosa, I-J. leaf variation, K. horned fruit, L. seed



△ **Scrub Beefwood** *Stenocarpus salignus* see page 342. Photograph by David Hockings.

▽ *Banksia menziesii* see page 351 for its commercial development



Stenocarpus

The Fire Wheel Tree genus

by Alec Blombery*

Stenocarpus, a genus of 25 species was first named by Robert Brown in 1810 and takes its name from the Greek "stenos" — narrow and "karpos" — fruit. The nine Australian species are found in eastern New South Wales and Queensland, the far north of the Northern Territory and the northern Kimberley region of Western Australia, New Guinea, Aru Islands, with the greatest number of species in New Caledonia.

The genus consists of medium to large trees with alternate leaves which in their juvenile stage are frequently lobed, usually becoming entire in the flowering stage, a common character found in many species of the family Proteaceae. The flowers superficially resemble those of *Grevillea* with the apex reflexed in bud. When open the perianth splits into 4 slender rolled back lobes with the style extending upwards and terminating in a flat oblique apex or pollen presenter; at the base of the style there is a semi-circular nectary gland. The flowers are arranged around a central axis into an umbel sometimes in racemes; these inflorescences are usually produced in the upper leaf axils, often with several inflorescences grouped together.

The fruit is usually a long narrow slender, tough oblong, cylindrical, or rarely a flattened semi-circular follicle as in Figure 1G, which when ripe splits open exposing 2 rows of overlapping winged seeds with membranous wings, Figure 1F.

Stenocarpus sinuatus Fire Wheel Tree**

A rainforest tree growing to about 30 metres in height, with a greyish-brown, slightly rough bark. The shiny green leaves with wavy edges are paler in colour beneath, varying considerably in shape and size; juvenile leaves may be up to 48 cm long and often deeply-lobed in a pinnasect manner; or may have a few to only one lobe; mature leaves may have entire margins as in Figure 1A and B.

The bright red to orange red flowers are tubular, about 25–38 mm long in bud and arranged into a wheel-like umbel of 6 to 20 flowers as in Figure 1C and the photograph on page 333, usually with several umbels together in the upper leaf axils; when the flowers open, the 4 lobes roll back and the style extends upwards.

The fruit is a leathery, cylindrical somewhat boat-shaped, follicle, about 5 to 10 cm long, Figure 1G, and when ripe splits open and releases a number of winged seeds.

The species occurs in rainforest areas from the Nambucca River in north-eastern New South Wales, extending through eastern Queensland to New Guinea and grows in rainforest and open areas.

*I wish to thank Dr Peter Weston and Dr Don Foreman for their assistance in early discussions on *Stenocarpus*. Dr Foreman has revised the genus, named 3 new species as published in *Flora of Australia*, Volume 16.

**Editor's Note — This would be one of Australia's most notable trees, magnificent in flower, but such a large tree. When a mature branchlet is grafted on to a vigorous seedling it is possible to have a tree to two metres high displaying the unique fire wheel of flowers to be admired. We need competent people to do these grafts from trees in their area, see page 378.

This shrub to tree which grows from 2 to 30 metres in height has a greyish slightly rough bark. The leaves, Figure 1J, are shiny, ovate-lanceolate to elliptical with slightly wavy margins and are 6.5 to 10.5 cm long and 2.5 to 4.5 cm broad, juvenile leaves are usually large and lobed. The white to greenish-white flowers, are 8 to 12 mm long in bud, open with the 4 slender lobes rolled back and the greenish-cream style is bent upwards; flowers are arranged in umbels of 10 to 30, with several umbels occurring in the upper leaf axils. The cylindrical to oblong leathery follicle about 7 cm long and about 5 mm wide opens when ripe and releases a number of winged seeds.

There could be more than one species involved. It occurs from Milton on the south coast of New South Wales to north-eastern Queensland in moist sheltered gullies and rainforest, also along rivers in drier conditions, often growing in sand.

Stenocarpus angustifolius

A small tree to 5 m high with greyish, slightly rough bark. The leaves on the older and flowering growth are entire, linear-lanceolate, 5 to 18 cm long and 1.2 cm broad, tapering to a short petiole with the apex acuminate; new growth is pubescent; the juvenile leaves are usually lobed in a pinnasect manner. The creamy white flowers to almost 10 mm long are carried on slender pedicels which, with pubescent perianth and ovary, are arranged in umbels of 12 to 20 flowers in the upper leaf axils. The fruit is a cylindrical follicle about 10 cm long which, when ripe, splits and releases a number of winged seeds.

It occurs in Eucalypt woodland and Riparian Forest along creeks and rivers from south-west of Townsville to the Atherton Tableland in north-east Qld.

Stenocarpus cunninghamii

A tree to 10 m in height. The new growth has a covering of rusty hairs which soon become deciduous as growth develops. The adult leaves are entire dull green oblanceolate to narrowly oblanceolate or narrowly elliptic, straight or falcate, 2.5 to 11 cm long and 0.4 to 1.8 cm wide with an extended base and an acute or obtuse apex, and mucronate, with 3 to 5 longitudinal veins. The juvenile leaves are elliptic in outline, simply lobed or deeply bipinnately lobed, with the lobes linear. The flowers are yellow, appearing white when open, strongly perfumed, glabrous, 4 to 5 mm long and in umbels of 14 to 21 flowers occurring in the leaf axils or on the older branches. Fruit is a linear woody follicle 4 to 6 cm long with a number of oblong winged seeds.

This species extends from the coastal areas of the Kimberley in Western Australia to Port Keats in the Northern Territory, in narrow sandstone gorges.

Stenocarpus cryptocarpus

A tree to 25 m in height with a buttressed base. The branchlets are rusty brown or with a covering of rusty brown hairs. The adult leaves, Figure 1K, are entire, elliptic, oblong or obovate, 9 to 14 cm long, with a glossy green upper surface and slightly lighter coloured beneath. The juvenile leaves are mostly bipinnate, some further divided, and up to 115 cm long margins are not undulate.

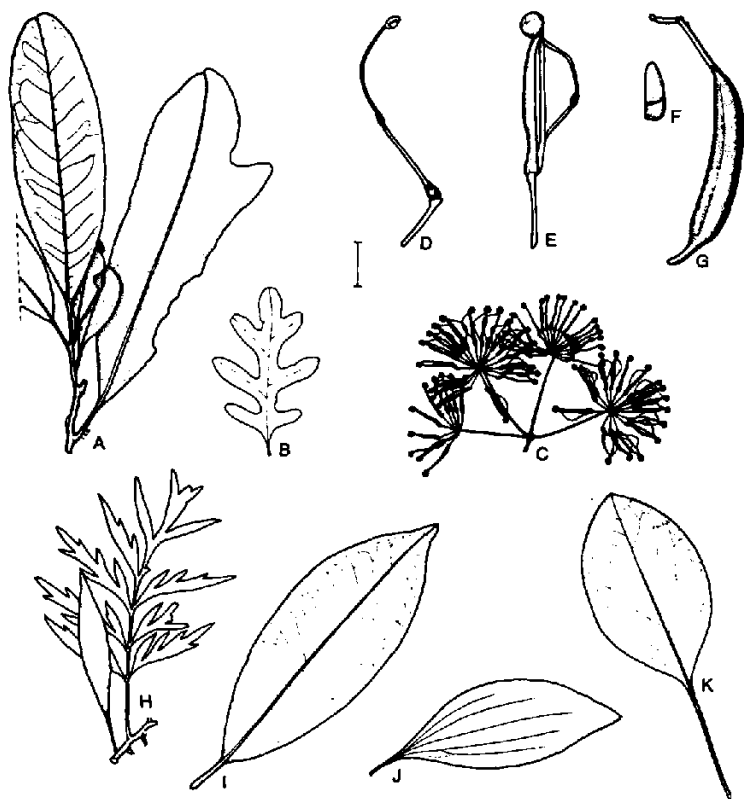


Figure 1 sketches by L. Button as in *Flora of Australia*, Volume 16

Stenocarpus sinuatus A–G. Leaf margins undulate, variously entire as in A to lobed as in B; the bright red flowers arranged like spokes in a wheel, each spoke a complete flower as in E, the stigma, style, ovary and nectary glands as in D, the flower when fertilised forming a fruit follicle as in G containing the seed F.

Stenocarpus davallioides has both entire and dissected leaves as in H, flowers creamy green with sparse rusty hairs, strongly perfumed.

Stenocarpus reticulatus has leaves as in I, lanceolate to elliptic with conspicuous mid vein and veins on both surfaces. The flowers are creamy white, minutely hairy and strongly perfumed.

Stenocarpus cryptocarpus has leaves as in K, elliptic, oblong to obovate, glossy when fresh, the mid and lateral veins well defined, flowers cream with rusty hairs, strongly perfumed.

Stenocarpus salignus has leaves as in J with a distinct midrib and up to 8 longitudinal veins evident, darker in colour and glossy above; white to greenish white flowers to 30 in a head.

Stenocarpus verticis has larger leaves, broadly lanceolate to elliptic, dark glossy green above with 3 to 5 major longitudinal veins. The flowers are creamy with rusty and greyish hairs, 40–50 flowers per head.

Stenocarpus angustifolius has leaves narrowly lanceolate, 1–2 cm wide, shiny above, light green below. The flowers are creamy white with soft long hairs.

Stenocarpus cunninghamii has leaves as in J, narrowly lanceolate to elliptic straight to falcate, dull green above. The flowers are yellow, appearing white when open.

Stenocarpus acacioides leaves are narrow elliptic, dull green above with 4–8 longitudinal veins.

The flowers of *Stenocarpus cryptocarpus* are cream with rusty brown hairs, perfumed, in umbels of up to 20 flowers which occur towards the ends of the branchlets flowers are 20 to 30 mm long. The fruit is a narrowly oblong follicle 10 to 13 cm long. The seeds have not been seen. This species is restricted to the Boonjee area from the McDowall Range to the east coast in northern Queensland and grows in rainforest from 10 to 1,000 m elevation.

Stenocarpus verticis

A tree to 20 m in height. The new growth is rusty, or rusty and grey silky; the hairy covering often persisting on the branchlets and leaves. The adult leaves are entire, elliptic, broadly elliptic, or broadly lanceolate, 5 to 15 cm long, 1.7 to 7 cm wide, extended at the base and acute, or obtuse at the apex with 3 to 5 longitudinal veins and non-undulate margins, and are shiny above and dull beneath. The juvenile leaves are pinnately 3 to 7 lobed and lanceolate or elliptic in outline, 1.8 to 3 cm wide. The flowers are cream with brown to grey hairs and 7 to 9 mm long in umbels of 40 to 50 flowers and are axillary, occurring singly or in cymes with the umbels opposite. The fruit is a linear woody follicle 3 to 8 cm long; the seeds of this species have not been seen.

This species occurs from the Northern Territory from Melville Island to the Gove Peninsula and across to the Olive River area of Cape York Peninsula of Queensland. It grows in monsoon thickets on laterite and sandstone.

Stenocarpus davallioides*

A tree to 40 m in height, with a slightly buttressed base. The new growth has a covering of brown hairs which are shed as growth becomes older. The adult leaves are entire, pinnate, bipinnate or tripinnate with the upper surface shiny green, and the lower surface lighter in colour, surfaces glabrous margins not undulate, lanceolate in shape, 5 to 13 cm long with 2 well defined veins, the pinnate, bipinnatisect and tripinnatisect leaves 8 to 20 cm long. Juvenile leaves are bipinnate and finely divided resembling a fern frond and are up to 42 cm long. The flowers are 8 to 12 mm long, creamy green, with a sparse covering of rusty hairs, and in umbels of up to 15 flowers occurring in the leaf axils. The fruit is a narrowly oblong follicle 6.5 cm long and contains up to 8 winged seeds. This species is restricted to the Mt. Lewis and Thornton Peak areas of northern Queensland in rainforest at elevations of 600 to 1,260 m.

Stenocarpus acacioides

A tree to 12 m in height. The new growth has a covering of rusty hairs that do not persist on the older growth. The leaves are dull green, leathery, entire, elliptic, or narrow elliptic, 4.5 to 11.5 cm long and 0.7 to 3 cm wide with the base extended and the apex obtuse or acute, margins are not undulate, there are 4 to 8 longitudinal veins. The juvenile leaves unlike most of the species are entire and not divided and are deltoid to ovate in shape, 7.3 to 12 cm long, and 5.7 to 11.1 cm wide. The flowers are white, glabrous 8 to 15 mm long, and in umbels of 19 to 22 flowers occurring singly or in clusters of 2 to 3 umbels in the leaf axils. The fruit is a linear woody follicle 5.5 to 15 cm long with a number of winged seeds. This species occurs across Northern Australia from the Kimberley area, WA, to the Northern Territory in eucalypt woodland.

*Editor's Note: The fern-like leaves, see Figure 1H, make this a unique, very attractive tree worthy of further research. One can marvel at the horticultural treasure this tree would be if crossed with *Stenocarpus sinuatus*: so that it carries an abundance of the bright red fire wheel flower heads. Who will take up the challenge?

***Stenocarpus reticulatus* Black Silky Oak**

A large tree to 35 m high with greyish, slightly rough bark. The broad lanceolate, oblanceolate or elliptical leaves are 5 to 17 cm long and 2 to 5.8 cm wide. Both upper and lower surfaces of the leaves have distinct reticulate venation and the lower surface is lighter in colour; the margins are entire. Unlike the juvenile leaves of other species of *Stenocarpus*, the leaves of this species are entire and not lobed. The flowers are creamy-white, 20 mm long, with the outer surface of the perianth lobes lightly pubescent, perfumed; the inner surface of the perianth lobes in the lower part have a dense tuft of long brown hairs; the ovary is pubescent, with the glabrous style terminating in a broad flat pollen presenter at the apex. The flowers are produced in axillary umbels of 10 to 13 flowers. The fruit is a somewhat flattened semi-circular swollen follicle 8.5 cm long, 5.5 cm wide. It occurs only on the Atherton Tableland, northern Qld., in rainforest at 660 to 960 m elevation. ■

Proteoid Root Systems

by Byron Lamont*

Proteoid (pronounced prot-ee-oid) roots are dense clusters of rootlets that are produced by all cultivated species of Proteaceae. Individual clusters vary in length from a few millimetres to over 10 cm and in width from a few mm to up to 4 cm and may consist of hundreds or even thousands of extremely hairy rootlets. As a result, when alive, they cling firmly to soil particles. When excavated they may look like a clod of earth. They are easily recognised when pot plants are tipped out of their containers as flattened clusters (white if active, brown if dead) where the soil mix touches the sides. Individual proteoid roots survive 2–6 weeks before withering. These clusters are quite different from mycorrhizas where fungal threads replace the root hairs. Mycorrhizas are a fungus living in association with plant roots which do not occur in dense clusters. The aim here is to review the current status of knowledge about these peculiar roots and their role in horticultural practice.

Occurrence in the root system

Seedlings usually possess scores of proteoid roots by the end of their first growing season. They occur spontaneously and do not need any special agent to initiate their formation. By the second year they may account for up to 50% of the weight of the root system. As the plant ages, proteoid roots make up an increasing proportion of annual growth of the near surface root system. They tend to be concentrated in a 2–5 cm thick mat at the soil surface. When decomposing litter is present they are even more concentrated in this than in the humus-containing layer beneath. Proteoid roots will grow up into the litter under the plants as the litter decomposes. All species tend to form a surface mat of proteoid roots, but it is most extensive in *Banksia* and *Dryandra*. Proteoid roots can arise either from ongrowing growth of the normal lateral roots — they have been located up to 9 m away from the base of several *Banksia* species, or they can develop on new laterals produced adventitiously often around the base of the parent plant. Proteoid roots are more concentrated under the plant's canopy than outside it.

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The Function of proteoid root systems

The surface area to weight ratio of proteoid roots may be 15 times that of the parent roots. This large surface area was originally held responsible for up to 13 times greater uptake of labelled phosphate. More recently, work has shown that this structure provides greater access to soil particles and so shortens the diffusion path for nutrients. In a recent series of papers, Grierson in Australia and Dinkelaker in Germany, have demonstrated that proteoid roots have a strong reducing, acidifying and mobilising capacity for poorly-soluble sources of manganese, iron and phosphorus. This results in increased rates of nutrient release from the soil particles and their diffusion to and exchange at the root surface. Proteoid roots act like a sponge as well as a mat, but their role in water absorption has received little attention. They readily form in wet pockets of soil, even during summer when the rest of the surface root system is dry.

Factors affecting proteoid root production

The number of proteoid roots in the root system varies greatly with soil type. In one experiment, as the proportion of clay to sand was increased, normal root growth fell slightly in three *Banksia* species, but proteoid root production dropped markedly, only to 3% of root weight in *B. aemula*. As plant growth increases in response to increasing soil nutrient availability, the number of proteoid roots at first increases, then it decreases sharply to zero. If the initial levels of nutrients in the soil or plant are high, the only response observed may be a decrease in proteoid root production when extra nutrients are applied. In one experiment, when organic fertiliser high in phosphate was given to 18 month-old plants in sand-peat, they grew 20% larger, but the number of proteoid roots fell from 390 per gram of root to zero.

Hakea prostrata was grown in sand culture for 6 months at different levels of nitrogen (N) and phosphorus (P). Plants at high levels of nutrients lacked proteoid roots and had high shoot/root ratios compared with those possessing proteoid roots. Hence, absence of proteoid roots implies increased susceptibility to drought, for a given shoot weight is supported by a much weaker root system than in plants with proteoid roots. In *Grevillea rosmarinifolia*, *Hakea suaveolens* and two *Banksia* species, plants only produced proteoid roots when N and P were omitted from the nutrient solution in sand culture. This is usually accompanied by an increase in root growth but not always a drop in shoot growth.

There is an inverse relationship between nutrient content of the shoots and percentage of the root system that is proteoid. Cuttings of *Grevillea* 'Poorinda Firebird' were placed in soil mixes which received 1.5 or 3.0 kg of 240 day resin-coated fertiliser per cubic metre or blood and bone at 2.5 kg/m³. Plants grew well and possessed 10–20 proteoid roots when clay-loam soil was added to the soil mix in the ratio of 1:3 — the soil fixes P and buffers its potential toxic effects. Plants in unamended soil were half their size and possessed only 0–3 proteoid roots. This was clearly due to P toxicity, and is associated with low proteoid root production. The message is to be careful with artificial fertiliser, especially if they are high in P. It may be safer to use an organic source of nutrients.

Top-dressings or localised pockets of partly decomposing organic matter stimulate root growth generally and proteoid root production in particular. This appears to be related to the extra nutrients available, as there is no stimulus when nutrients are already high in the plant.

Stimulus of root growth is due to the greater microbial activity in these layers of decomposing matter. There is now quite good evidence that certain soil bacteria have an inductive role in the initiation of proteoid roots. However, these micro-organisms never invade the roots, and there is no truth in earlier ideas that proteoid roots are a type of mycorrhizal symbiosis.

In seasonal climates, proteoid root production is seasonal as it is tied to growth of the surface parent roots. Limited additional water in summer can produce new shoot growth without new roots. Greater amounts of water will induce new root growth, including proteoid roots, as well. Total root growth, as well as percentage of the root system that is proteoid, is greatest in constantly moist soils and least in permanently dry soils.

The root system and total proteoid root production are retarded under water-logged conditions. The number of proteoid roots per unit weight of root system under water logged conditions may actually increase as they possibly take on an aerating function. There is limited evidence that pruning of young plants may reduce general root growth as well as the contribution of proteoid roots to the root system, but this needs study at the adult level. Vigorous shoot growth recovery means that the root system is recovering as well.

Management implications

Proteoid roots, and their supporting lateral roots, form a dense mat at the soil surface. This is best developed under the plant canopy but can extend a distance of 6 times beyond the width of the canopy in old plants. This surface mat appears to have a vital role in nutrient and water uptake by the plant, especially during the growing season. For example, one year old plants of *Hakea laurina* grew 26% larger when the proteoid root mat was in the uppermost 12 cm of the soil profile, than when it was shifted artificially to a depth of 24–36 cm by placing decomposing litter at that depth.

The mat develops at the soil surface, whether it is high in organic matter or not. However, it is much better developed in the presence of actively-decomposing litter. Use of black plastic as a mulch/weed suppressant has the disadvantage that it stops the proteoid roots growing up into the litter as it accumulates on the surface. Woven matting has more to recommend it in this regard, but to what extent it strangles older roots has not been tested.

These observations imply that turning over the soil, especially close to the plant, could be lethal as the most important part of the root system is in danger of destruction. Other approaches to weed control must be adopted. Post-emergence contact herbicides, mowing or mulching are to be favoured. It also follows that control of weeds is important as their shallow roots will actively compete with the proteoid roots. Hand-pulling should be done in a way to minimize root damage.

The presence of the proteoid root mat implies that the plant is particularly sensitive to chemical treatments applied at the soil surface. Applications of fertilisers, nematocides and fungicides have all been known to induce toxicity symptoms in Proteaceae at levels recommended for other plant groups. It is especially important to delay application of fertilisers after any type of root disturbance, as the damaged rootlets lose control over rates of uptake. Some species considered phosphorus-sensitive were not so in laboratory experiments. It seems these species only became sensitive to P when exposed to root damage, e.g., through transplanting, weeding, water deficits, frost, root pathogens and pests.

Delay surface application of fertiliser until at least two weeks after transplanting. The sparing use of fertilisers and those low in available P, such as hoof and horn and isobutylidenediurea, is preferred in soil-less potting mixes. An alternative is to incorporate material with high P-fixing properties, such as humus and clay-loam soil. These would also be valuable as top-dressings for row-crop plants. To avoid a sudden and lethal uptake of nutrients in response to heavy fertilising, have relatively high initial levels of nutrients in the potting mix or field soil. This reduces the presence of proteoid roots in the root system and buffers the effects of a sudden influx of chemicals. However, it carries the risk of nutrient toxicity, reduction in growth and flowering and increased susceptibility to drought, through an increased shoot/root ratio. There can be no denying that the presence of abundant proteoid roots is a sign of a healthy plant. ■

Banksia research

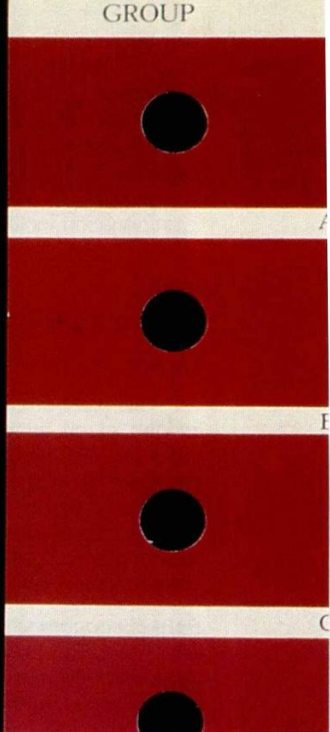
The University of Adelaide

Under the direction of Margaret Sedgley*

Research on the *Banksia* genus has been underway at the Waite Agricultural Research Institute of the University of Adelaide for almost ten years. Our major objectives are as follows:

1. To develop new, improved cultivars of *Banksia*. The main aim is to develop new varieties for cut flower production, but we are also interested in plants for gardens, cut foliage and pot plants. So far we have developed three cultivars for cut flower production, 'Waite Orange', 'Waite Crimson' and 'Waite Flame'. 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, deeper colour in the flower heads and reliable performance in cultivation.
2. Propagation of *Banksia*. We have investigated cutting propagation of *Banksia*, and have successfully produced rooted cuttings of *Banksia coccinea*, *B. hookeriana*, *B. prionotes* and *B. menziesii*, although success with the latter is lower than with the others. We routinely use indolebutyric acid (IBA), at a concentration of 1,000 ppm for field grown material, and 5,000 ppm for mother plants kept under cover. We also plan to conduct research into grafting.
3. To understand the breeding biology of *Banksia*. This is essential for work aimed at breeding new varieties. We have found that the pollen is available when the flower opens. However, the female parts of the flower are not receptive to pollen until three days later. We have also found that pollen from another plant is more successful in achieving seed set than self pollination.
4. Interspecific hybridisation of *Banksia*. Natural interspecific hybrids have been reported in the wild, and in cultivation. In addition, most horticultural plants, such as roses, have undergone some interspecific hybridisation in their past, and one of our superior cultivars, 'Waite Orange' is a natural interspecific hybrid. We are conducting interspecific crosses to investigate limits to compatibility within the genus. We have achieved success with the cross *B. hookeriana* × *B. prionotes* (the same parental species as for 'Waite Orange'), and others.

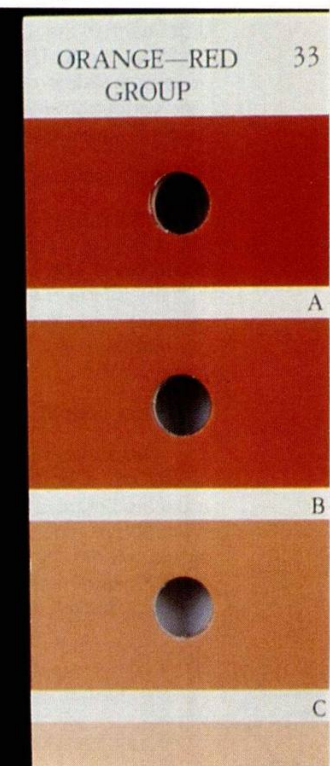
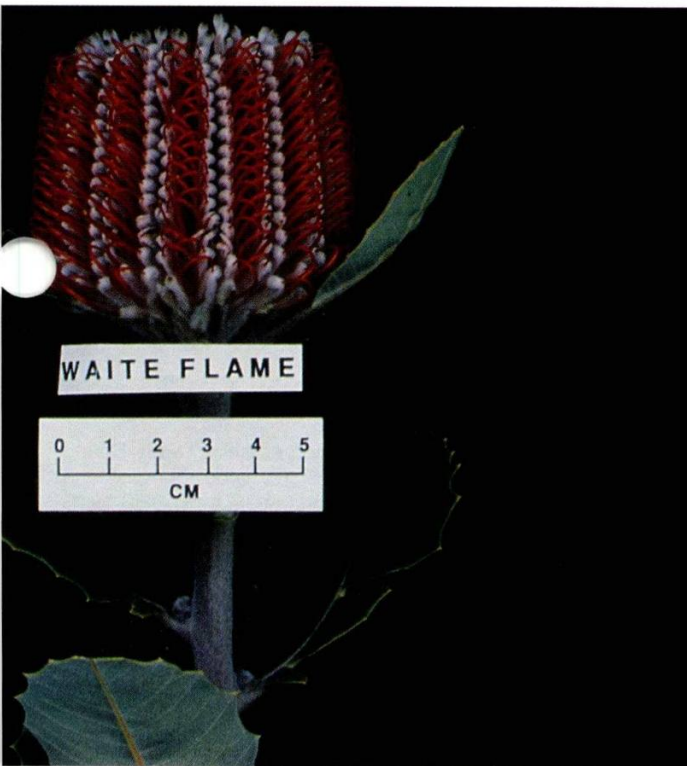
*Department of Horticulture, Viticulture and Oenology, Waite Agricultural Research Institute, The University of Adelaide. This article was composed by the Editor from notes sent by Dr Margaret Sedgley. We are indebted to Margaret Sedgley for her dedicated work on our flora. The Australian Flora Foundation has contributed to funding this research by courtesy of The Society For Growing Australian Plants NSW.



△ *Banksia coccinea* 'Waite Crimson'. See the next page for details.

▽ *Banksia coccinea* 'Waite Flame'.

A commercial plantation of a **usual form of the species** is shown on page 353.



5. Genetic variability of *Banksia*. This is very important for the development of new cultivars, as variable populations tend to have new and unusual characteristics. It is also important in understanding the conservation status of plants in the native habitat. We use non-destructive biochemical methods to measure genetic variability on very small pieces of tissue. This approach can give very useful information including, which plants are pollinating which, and how many plants are needed for a healthy breeding population.

***Banksia* Cultivars bred for the cut flower trade**

***Banksia* 'Waite Orange'**

Photograph on page 353

This plant arose from a single open pollinated seedling of *Banksia hookeriana* as part of an intensive selection programme. The other parent being *Banksia prionotes*. The hybrid is intermediate between the parents in leaf colour and shape. The flower heads are similar in both form and colour but 'Waite Orange' produces a greater number of flower heads. Peak flowering time is in May, later than *B. prionotes* (March) and earlier than *B. hookeriana* (July) extending the peak flowering period with a greater abundance of long flowering stems and an attractive flower colour. Photographs of parents on page 352.

Banksia coccinea is a floral gem in horticulture and a commercial goldmine for the right form. The photograph on page 353 shows a plant grown for the cut flower trade from a seedling randomly selected. To consolidate a market, consistency in flower head size and colour and leaf colour and shape is essential.

Selection criteria for forms of *Banksia coccinea* best suited for use in the cut flower trade were based upon yield, colour, bloom quality and time of flowering. A large number of forms were studied the final selection being of two meeting these desired features. The final selection was made from a large range of rooted cuttings from each of the selected forms propagated in a sand/peat/perlite mix grown through to 20 cm pots. The final cultivation trial design was using 10 plants of each variety in a completely randomised layout. The measurements quoted are of leaf length and width from mid point of 17 samples per plant for each variety. The flowers were from 10 samples from one plant per variety.

***Banksia coccinea* 'Waite Crimson'**

Photograph on page 349

Description of plant: perennial, medium to tall bushy, branching, late Spring flowering, evergreen shrub. *Leaf:* 22–75 mm long, 14–50 mm wide, obovate and truncate; shortly petiolate, dentate margin, mid green RHS 137B and RHS 191B on upper and lower surfaces respectively, moderately hairy when young. *Inflorescence:* terminal and squat, 65 mm long, 83 mm wide with styles exserted, crimson. *Flower:* numerous, hairy grey perianth RHS 190D, crimson style RHS 53A. Peak flowering time October.

***Banksia coccinea* 'Waite Flame'**

Photograph on page 349

Description of plant: perennial, medium to tall, bushy, branching, early Spring flowering, evergreen shrub. *Leaf:* 28–90 mm long, 14–55 mm wide, obovate and truncate shape, shortly petiolate, dentate margin, mid green (paler below RHS 191B than above RHS 137B), moderately hairy when young. *Inflorescence:* terminal and squat, 55 mm long and 90 mm wide with the styles exserted, overall colour orange red. *Flower:* numerous, hairy grey perianths RHS 190D, styles orange red predominantly RHS 33A with some RHS 25A and RHS 28A. Peak flowering time July.

This is the extreme in colour variation, both between plants and during the flowering period. Most blooms are pink or red, but bushes bearing apricot, yellow, bronze and brown blooms have been recorded. The colour derives collectively from the 700 to 800 individual flowers that comprise the flower head.

Red blooms are characterised by flowers having red styles and pink perianths, pink blooms have pink styles and pale pink perianths, apricot blooms have deep apricot styles and pale pink or yellow perianths and yellow blooms have yellow styles and perianths. Further, lighter-coloured flowers are found on the shaded side of the flower head as it develops and partially shaded blooms display uneven colour development. The one plant will produce lighter-coloured blooms early in the flowering season.

On plants under observation all producing red blooms in March, only 40% were still producing red blooms in June, the remainder darkening to a deep red or wine colour. Only 15% of the plants producing pink blooms in March were still producing pink blooms in June, the remainder being a very deep pink. Plants initially producing apricot flowers later produced pink flowers, a few to red. On plants with originally yellow flowers, half had become apricot at the end of the season. This deepening of flower colour over the flowering period coincided with a decrease in temperature and the number of sunshine hours. Not all plants observed experienced this flower colour change over the seasons. Further, there is the seemingly change of colour as the flowers mature from the bottom upwards.

Banksia research — Control of flowering and breeding systems

by Mary Rieger and Margaret Sedgley

Study 1 To improve understanding of the control of flowering in relation to photoperiod and temperature and to increase knowledge of the floral initiation trigger for *Banksia*. The floral initiation of *Banksia coccinea* and *Banksia hookeriana* were examined in relation to controlled environment conditions. Both species were subjected to four different treatments long (16h) and short (8h) day lengths at high (25/20°C) and low (15/10°C) temperature. During these treatments vegetative flushing, vegetative extension growth and flowering were measured. *Banksia coccinea* showed a significant response to photoperiod while *Banksia hookeriana* responded to temperature. The flushing pattern (best flowering display) for the two species was similar with most flushing occurring in late spring. The most significant vegetative extension growth for both species occurred during the flush period of late spring/summer. *Banksia coccinea* short hours and 25/20°C, produced maximum average vegetative growth of 6 cm. This treatment also resulted in maximum flowering for *Banksia coccinea*. Maximum vegetative growth for *Banksia hookeriana* was observed at both day lengths and 25/20°C. The two high temperature treatments resulted in flowering at both 16h and 8h, but no flowering was observed for low temperature treatments.

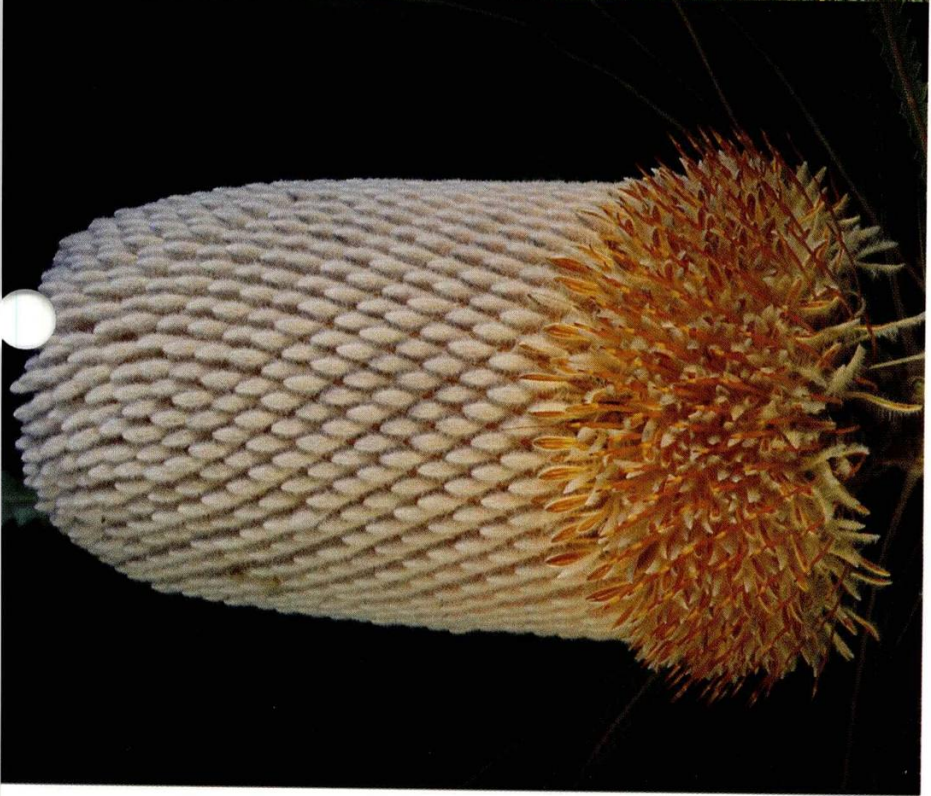
Study 2. Using molecular biology techniques to explore areas such as pollen competition and gene flow may improve practices. Gene flow in a small population was examined for two species, *Banksia praemorsa* and *Banksia prionotes*. Open pollinated seed was collected from a number of inflorescences and the DNA extracted. The RAPD technique was used to identify the father of each seed and the frequency and direction of pollen and therefore gene flow. Honeybees and honeyeaters were the most common agents of the pollen transfer. ■



Banksia coccinea



Banksia 'Waite Orange'



The Rose Mallee

A Rare Ornamental *Eucalyptus**

Photograph on page 356

Reproduced from the "Rose Mallee Recovery Plan" produced by the Department of Conservation and Land Management, Western Australia.

The Rose Mallee, *Eucalyptus rhodantha* Blakely and Steedman, was described from material collected near Gunyidi by Henry Steedman in 1934. It is a low spreading mallee up to 4 m high, with smooth greyish brown stems and glaucous branchlets. It has distinctive silvery grey leaves that are opposite, sessile and often clasping the stems. The leaves are orbicular to cordate, to 8 cm × 8 cm, with the apex ending in a short point. The buds are glaucous, to 5.5 cm long × 4 cm wide, with a beaked, conical budcap. They are pendulous and usually solitary, on long, thick pedicels and peduncles. The fruits are large, to 7.5 cm across, bright red to pink, or rarely creamy yellow. The fruits are woody, hemispherical to top-shaped, to 3 cm long × 5.5 cm wide, and containing dark brown, winged seeds. There is some variation within the species, with plants in the Three Springs area having greener, less glaucous leaves. Plants at the Watheroo sites are most distinctive and possess the typical characteristics.

Eucalyptus rhodantha closely resembles *Eucalyptus macrocarpa*, differing in its smaller, pendulous buds and fruits, more compact habit and less elongated leaves. The two species are not associated in the field. Confusion about the status of *E. rhodantha* was due to the misidentification of *E. macrocarpa* × *E. pyriformis* hybrids. Subsequent research established that it is not a hybrid and it is now regarded as a highly restricted species, distinct from other eucalypts but having some relationship with *E. macrocarpa* and *E. pyriformis*.

Eucalyptus rhodantha flowers between March and November, with peak flowering from June to August. It produces few flowers per plant in comparison to other eucalypt species, with individual plants differing in the number of flowers and in the time and duration of flowering. The flowers are long-lived (20–30 days) and yield copious quantities of nectar, mainly during the day. They are protandrous, most of the pollen being shed from the anthers within six or seven days after anthesis. The stigma becomes receptive after about 12 days. Vegetative growth and bud development occur during the summer months. Predation by the bud weevil, *Haplonyx maximus*, and the Port Lincoln Parrot, *Barnardius zonarius*, reduces the number of buds which will eventually flower.

The flowers are pollinated by several species of birds and possibly small mammals. Investigations of the mating system indicate that it has a predominant outcrossing but a significant proportion of self-pollination. Protandry does not prevent self-pollination in *E. rhodantha* as several flowers at different stages may be present on a plant at any one time.

***Extinction!** This beautiful plant is in danger of extinction, lost for all time. This article is a record of the research to date and of what our responsible scientists **hope to do**. This sad story can be repeated a thousand times with plants due for extinction if informed action by a responsible government is not taken soon. **We need Australian Flora Botanic Gardens.**

Australian Flora Botanic Gardens are described in the Number 142 issue where our proposals for the conservation of the Australian continent were suggested as a prime objective for the celebration of 100 years of federal government in 2001. The politicians are not interested.

There are only two relatively undisturbed populations of *Eucalyptus rhodantha*. They occur on uncleared private land in the Watheroo area with stands of 37, 180 and 150 plants on cleared and grazed farmland and degraded road verges south-west of Three Springs, 14 plants in one stand and 8 plants on another. They grow on sandy soils, often with some gravel, in flat or gently undulating country. The populations on uncleared land occur as almost pure mallee communities over low heath. Eucalypt species found in the vicinity of *E. rhodantha* populations include *E. loxophleba*, *E. eudesmioides*, *E. tetragona* and *E. tottiana*. The climate of the area is extra-dry with the majority of the rainfall (388–425 mm) during the winter months (May–August). The summers are hot and the winters cool with only occasional frosts.

Selection favouring heterozygous progeny, which are more likely to be produced by outcrossing, appear more likely to survive at all stages. Despite the range in size of the remnant stands of *E. rhodantha* the average levels of genetic diversity found in all of them were high. It appears that gene flow within populations is restricted so that local neighbourhoods form and become genetically different. It appears that the increase in inbreeding was not associated with decrease in reproductive output, as determined by the number of capsules produced per plant, although small remnants of *E. rhodantha* are less fecund and less vigorous. This may simply be the result of environmental degradation.

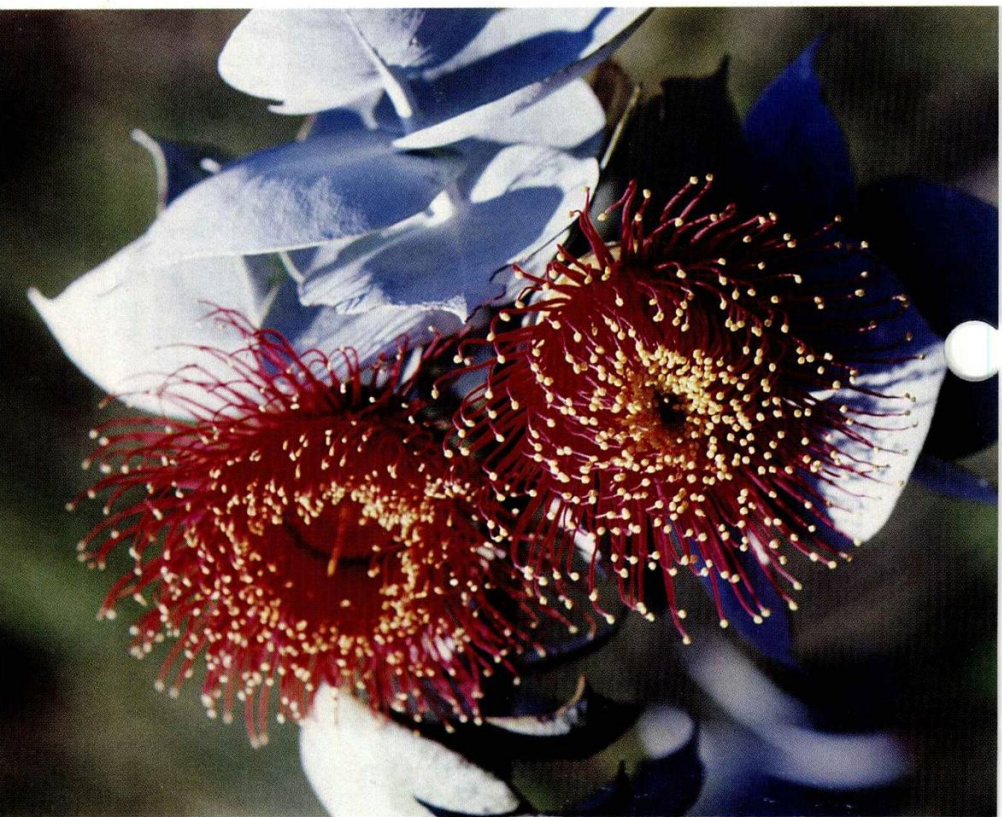
Plants in both the disturbed and relatively undisturbed stands of *E. rhodantha* maintain moderate levels of fruit and seed production. The fruits open and release seed in the absence of fire, and more than half the fruit on a plant can open during a single year. Despite this supply of seed no natural seedling recruitment has been observed in any of the stands. To study the effect of fire a moderate burn was conducted on a subpopulation of 30 plants in stand 4 in April 1986. An estimated 27,000 seeds held in the canopy were released following the fire but only six seedlings were observed and none survived to August 1987. In a study a burnt stand of 30 plants, 29 began coppicing at the onset of the first growing season (November 1986) after the fire. Some of the plants flowered during the 1988 season, two years after the fire. Depletion of seed after the fire by predators and wind was probably the major factor limiting germination.

A recovery plan to conserve populations at both Three Springs and Watheroo for a 10 year period from 1992 to 2001 inclusive is proposed. Acquisition of land for a conservation reserve at Watheroo is proposed. None of the other sites are suitable for acquisition as conservation reserves. As natural recruitment has not been observed at any of the sites, it is desirable to enhance the populations by introducing seedlings specially propagated.

Seed has been collected from all stands so that the range of genetic and morphological diversity is represented. In the smaller stands 1, 2, 3, 6 and 7 seed were harvested from up to five randomly-chosen fruits from all individuals in the stands. In the large stands 4 and 5 seed will be harvested from one fruit per plant from approximately 50 randomly-chosen plants within each stand. Seed was collected from all individuals of the var. *petiolaris* where possible. The seed will be maintained separately in long-term storage at the CALM Threatened Flora Seed Centre at the WA Herbarium. Seed from individuals in each stand will be maintained separately and not bulked. Seed will be available for cultivation on authorised projects such as the Three Springs Shire for planting in the town gardens, landcare committees and local farmers and commercial nursery men. This will reduce any pressure on natural populations from illegal seed harvesters.



The Rose Mallee *Eucalyptus rhodantha*, plant and flower, photo, Neil Marriott





Lambertia multiflora, plant by J. S. Beard, flowers by F. W. Humphreys



Australian Rhododendron

by Robert M. Withers

The first appearance of *Rhododendron* called *Rhododendron lochiaie* in a nursery catalogue was in the catalogue of Basil Hodgins at his nursery in Essendon, Victoria, in 1953. This plant has been widely grown since that time. Plants of this species have since been re-collected many times on mountains north-west of Cairns and this species has been used extensively in hybridisation with other species of Vireya group of *Rhododendron* species. This plant will be known as *Rhododendron lochiaie*.

The Hodgins Nursery species has turned out to be a different species from the one named *R. lochiaie* by Baron von Mueller in 1887 and collected on the Bellenden-Ker Range inland from Cairns. This species appears to have first been introduced into cultivation following a collection on Mt Bartle Frere in 1975 by David L. Jones and distributed from the wholesale nursery operated by W. Rodger Elliot then at Montrose, Victoria. To my knowledge this species has not been used in hybridisation. It will be known as *Rhododendron notiale*.

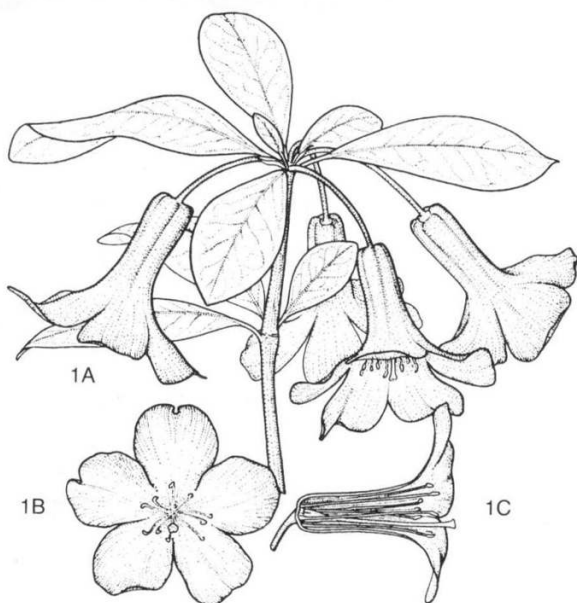
A nomenclatural difficulty exists in that Mueller's type of *R. lochiaie* comes from Mt Bellenden-Ker and is conspecific with the species described here as *R. notiale*. Under the ICBN, as its general provisions provide, the Bellenden-Ker plant should be called *R. lochiaie*. This would mean that the plant known as *R. lochiaie* to horticulturalists throughout the world requires another name. This course of action would result in significant disruption and confusion, contrary to the objective of the ICBN to promote stability in plant nomenclature. Lyn Craven submitted a proposal to *Taxon* that has now been accepted, for the conversion of *R. lochiaie* with a different type, to preserve current usage of the name *R. lochiaie*.

In cultivation in Melbourne, the main flowering period is during February and March, but I once saw a plant grown by the late Michael Spry, second President of our Society, which had at least one flower in bloom during each month of the year. The long flowering time is important, as although *R. lochiaie* has a main flowering period during February and March, it does not flower only during a peak period like so many other rhododendron species.

Horticultural requirements

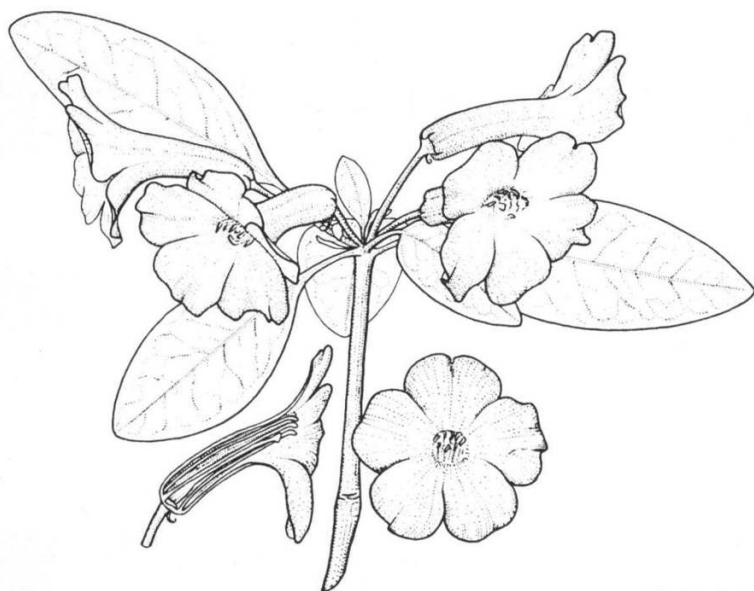
Rhododendron lochiaie and *R. lochiaie* F. Muell. are grown by enthusiasts in Victoria, Wollongong, Sydney, Northern Tasmania and Brisbane, and to a lesser extent in other areas throughout Australia. They are also grown in New Zealand, the United States, Japan, England and other overseas countries. Although these plants grow well in the ground in rich, well drained soils containing plenty of leaf mould, they grow better in containers such as hollowed out sections of tree-fern trunks containing rotted tree-fern fibre, peat moss and leaf mould.

The plants are not difficult to grow providing four basic requirements are understood. They require a good supply of moisture, good light, protection from extremes of temperature, and most important of all, good drainage. Dr John Rouse has demonstrated that although they prefer acid conditions, they in fact have a high requirement for calcium, and this can be added to compost as calcium phosphate which does not raise the pH too much.



Rhododendron lochiai, Figure 1 (above). The characteristics of this species are shown in **1C**, the flower (corolla) tube being straight, the pubescent (hairless) staminal filaments (with dark red anthers), spaced around the throat (the most being in the lower half) and the style in the lower part of the flower tube. The flowers are on long pendulous stalks.

Rhododendron notiale, Figure 2 (below). Here the flower tube is curved, the glabrous staminal filaments (with yellowish anthers) presented in a cluster at the top of the throat with the style also in the upper part of the flower tube. Sketches by K. R. Thiele.





Rhododendron notiale



Rhododendron 'Liberty Bar'



Rhododendron 'Australia 11'



Rhododendron lochiai



Rhododendron 'Shantung Rose'



Rhododendron 'Arthur's Choice'

Rhododendron do not like extremes of temperature. They need protection from frost as they are frost tender, and they need semi-shade during the hot summer months. The foliage of plants subjected to temperatures below 5°C loses its gloss and becomes blotched with dull red patches. Horticulturally, Australian *Rhododendron* and hybrids have great versatility with long flowering displays, being ideal garden plants, plants for the patio, bush house or hanging baskets. As a cut flower, they are long lasting.

The largest plant of *R. lochiai* F. Muell. I have seen in cultivation was c. 1.5 m in height and 1 m in width. I have grown *R. lochiai* successfully in leaf mould in the fork of a Blackwood tree (*Acacia melanoxylon*) at Olinda in the Dandenong Ranges in Victoria. In the nature strip at the home of Dr John Rouse there is a plant of the *R. lochiai* hybrid, *R. 'Liberty Bar'* which is 2 m high and 1.5 m in width. In flower every month of the year it is a magnificent sight. ■

Name Change For Our Eucalypts!

An interpretation by W. H. Payne of the work of K. D. Hill and L. A. S. Johnson*

What the Aussie knows as gum trees or eucalypts remains unchanged. The long awaited name changes to the *Eucalyptus* genus are now upon us. Ken Hill and Lawrence Johnson have published a scientific paper in the journal of the Royal Botanic Gardens, Sydney, Volume 6 (2-3), September, 1995, and for us it is good news.

"Our studies indicate that the bloodwood groups are part of the *Angophora* clade, clearly separate from the remainder of the eucalypts. Consequently, the bloodwoods are recognised as a separate genus, *Corymbia*, which is quite clearly distinct from *Angophora* itself. The *Eucalyptus* group appears in our analyses as a single clade with a few species yet to be studied."

"We would stress that the English term 'eucalypts' should be used to include all of the complex. Thus 'the eucalypts' are *Angophora* + *Corymbia* + *Eucalyptus*." The scientists have left the escape hatch open with the addition of "+ any other genera that may be segregated". Ten years ago there was the almost absolute conviction that the genus *Eucalyptus* would be split up into at least seven genera and the forbearance shown by these responsible scientists in confining it to only one more genus *Corymbia* is acknowledged with heartfelt thanks by all Australians. Hopefully they will be able to contain their basic urges when it comes to the few remaining species that still puzzle them and leave them in *Eucalyptus*.

Bloodwood, now the genus *Corymbia*, what are they? It seems there are now 113 of them, 35 newly described species in this work, the remainder being previously known as *Eucalyptus* species or subspecies. I do not know what a bloodwood is, for that matter what defines an *Angophora*, so I will find out and advise you in a future issue. My knowledge stops short at an admiration for *Angophora costata*, the red trunked trees that adorn my garden and the Red-flowering Eucalypt now *Corymbia ficifolia*.

*Based upon "Systematic studies in the eucalypts, a revision of the bloodwoods, genus *Corymbia*" in *Telopea* Volume 6(2-3). This journal is published by the Royal Botanic Gardens, Sydney, and is available from them. Unless you are a scientifically competent botanist, do not seek to obtain one of the limited copies available as you will not be able to understand 95% of it. The scientific jargon is very heavy. *Australian Plants* does serve the general public by presenting scientific research in a readable form for us lesser mortals, hopefully in an issue shortly. ■

Would You Like To Help The Scientists?

You can make a contribution

We need seed of all species of the Fringed Violet, *Thysanotus*. Please collect some after the next flowering season and send to Dr. Krystna Johnson, University of Technology, Environmental Biology and Horticulture, Westbourne St, Gore Hill, 2065. Seed of the Yellow Flowered Iris (*Patersonia*) is also required as well as species of *Calectasia* the Tinsel Lily. Other science researchers are invited to seek help such as this.

Health Decline of Native Street Trees

From Institute for Horticultural Development, Knoxfield, Victoria

Just how healthy are our native street trees? According to a study conducted at the Institute for Horticultural Development, Knoxfield, they are losing their health, looks and their value as street trees in urban areas.

There is a crisis in performance in Australian native trees which is concerning councils and home gardeners. Most urban street trees are grown from seeds of existing specimens with no superior cultivars, or varieties, being grown. This has resulted in inbreeding and loss of genetic diversity. Unless seed variety management of urban street trees is undertaken, then the trees performance will continue to worsen. Inbreeding and self-pollination reduce the tree's ability to cope with pests, diseases and climatic changes.

CSIRO research conducted in the 1970s showed that genetic diversity was important, with eucalypts losing 40 per cent vigour after just one generation self-pollination. As well as inbreeding, a survey conducted state-wide also found poor adaptability to an area and interspecific hybridisation, or crossing between different species, had contributed to poor performance.

One solution to the lack of genetic variety was the establishment of elite seed orchards for the production of high quality seedlings. The first elite orchard for native trees used in ornamental horticulture in Australia, run at the Mt Gambier Prison in conjunction with IHD, will use this principle of outbreeding for developing new seed. The elite seed orchard specialises in red and dark pink flowered trees of *Eucalyptus leucoxylon* subspecies *megalocarpa*, and uses an out-crossing genetic design based on forest tree principle. The seedlings of *Eucalyptus leucoxylon* used in the elite orchard were taken from native forests around the Mt Gambier area. Through a process of selective breeding, all white flowering species of *Eucalyptus leucoxylon* will be removed from the genetic pool of the seed orchard, leaving only the red and dark pink varieties. Another seed orchard has also been planted near Cleve in the Eyre Peninsula. Elite clones could also then be propagated from cuttings or by tissue culture methods, as long as juvenile material can be established.

The study began five years ago, scientists gathering information on the performance of trees in 24 municipalities around Melbourne. Among species surveyed, yellow gum, New England Peppermint and Brisbane Box, lacked vigour or showed extremely variable performance.

Research is also being done to produce elite seeds of *Angophora costata*.

David Beardsell, a scientist from the Institute for Horticultural Development, said: "Research into native urban trees would assist local organisations and municipal councils to develop better quality native trees which will perform better. Ideally, what we need is a set of specifications for all of the industry so that we can implement policies for urban tree management. This would include greater communication between growers or nurseries and councils, to specify where the seed came from and to identify the genetic background of all planting material from tubestock to advanced trees."

Not only is variety diversity important to maintain native tree's performance in urban parks and gardens, but it is also essential for retaining the presence of diverse native wildlife, such as lorikeets, rosellas, honey-eaters and others.



Waratah flower heads are to be classified to suit export and local market requirements. Small flower heads are used in bouquets and wreaths. The red petal-like bracts that surround the head of the flower are an important part of the flower presentation.



Waratah Grown in Alkaline Soils

by T. G. Loffler, Waikerie, South Australia

"We have tried following the experts advice and still failed repeatedly". This is a comment from the last issue with which I can relate. I believe that some of the advice is incorrect. In particular that they do not grow in soil with a pH above 6.0 and that the application of phosphorus is detrimental (Ross Worral, in "Growing Waratah Commercially" he recommends the application of super phosphate).

During the late 1970s, early 1980s, "the experts advice" re banksias was that they would not grow in alkaline soils. Having seen a specimen of *Banksia ashbyi* growing in 100 mm of topsoil, above sheet limestone, I experimented with growing banksias at Waikerie, in the Riverland, in South Australia, on mallee soils with pH in excess of 8. I found that provided there was good drainage and by using ground mulch to provide a cool root run in the summer, I was able to grow in excess of 25 species, with some as commercial cut flowers. Although some varieties show some yellowing of leaves (iron deficiency), most plants adapt and improve after a few years. I have found this also applies with some species of *Grevillea*. All plants receive supplementary water via drip irrigation. Losses have occurred but this was mainly from black frosts (to -8°C) in spring 1994 and 1995.

In 1992 I commenced a waratah plantation with the aim of using them as commercial cut flowers. The soil is sandy loam (0–55 cm), then sandy clay loam (55–150 cm), then sheet/boulder calcrete. Soil pH varies from 9.5 at topsoil, to 10 at 150 cm depth. The plantation site was cleared land which had last been cropped 20 years previously. A $50 \times 30 \times 3.6$ m shade house of white windbreak cloth was erected. A weed inhibitor and mulching material (spun bonded 50 gm/sq metre Marix) was placed on the soil surface. Previous experience has shown that woven weed mats tend to prevent water and air penetration to the soil. This was covered with 200 mm of eucalyptus wood chips/leaf mulch between rows, with 50 mm depth $\times$ 300 mm width of 10 mm white gravel where the waratahs were to be planted. The use of gravel was to reduce the possibility of collar rot through the waratah trunks being in contact with wet leaf mulch. The plants were initially watered by drip irrigation. An overhead sprinkler system was later installed to reduce bract burning and flower damage. This is used during summer days of high temperatures (over 40°C) and hot winds. When water salinity levels are high a sprinkler system, installed at the edges of the shade cloth sides, is used to cool the wind without contaminating the waratahs with salt.

Six-hundred and fifty waratah seedlings, 100 mm in height, were planted in late May 1992. Regular applications of Agrichem Supa Humus, Supalron and Kelpac were applied through the drip irrigation system. In 1995/96 this was supplemented with foliar sprays of the above and Phostrogen. Also I have applied single strength superphosphate, fowl manure and blood and bone to the ground. To date 39 plants have died, 143 are less than 300 mm in height and the rest are of heights to 2.5 metres. Some plants display symptoms of yellow leaves (iron deficiency?). However most plants above 300 mm in height appear healthy. The waratahs commenced flowering in spring 1994. This year most plants above 300 mm in height have flower buds. Being seedlings the flower types/colours vary. Some are similar to registered cultivars, others have large floral bracts and/or also multiple small flowers along the trunk beneath the main flower.

Phytophthora Diseases

Part 1* — Their Control

by David I. Guest et al.**

Fungicides are commonly applied to tree crops as foliar sprays and soil drenches. The effectiveness of both methods as therapeutic and protective treatments for plant diseases is limited by the generally poor uptake of the fungicide into plant tissue, the rapid loss of activity due to the degradation by soil and phylloplane microbes, and loss to the environment through leaching and wash-off. Trunk injection is a novel technique that delivers a low volume of fungicide with minimum wastage and environmental contamination and achieves maximum persistence within the plant.

Xylem-translocated fungicides (e.g., benomyl, carbendazin, and metalaxyl) are restricted to the apoplast and move acropetally in the transpiration stream to the leaves. If the fungicide is translocated in the symplast as well as the apoplast, it will be xylem and phloem translocated, and will move both acropetally and basipetally in the plant. Both modes of translocation may be exploited to target the infection site of the pathogen. The only commercially available phloem-translocated fungicides are the phosphonates. These are active against Oomycetes such as *Phytophthora*, *Pythium*, and the downy mildews, all of which are serious pathogens of horticultural species.

Phosphonate is used, here to mean the salts and esters of phosphorous acid (H_3PO_3), which forms the phosphonate anion $\text{HPO}(\text{O}^-)_2$ in solution. It is used in horticulture as a partially neutralised solution of phosphorous acid, formed by the titration of phosphorous acid with potassium hydroxide, to yield a equilibrium solution of mono- and dipotassium phosphonate ions (KH_2PO_3 and K_2HPO_3 , respectively). The critical point that confers biological activity on phosphonate appears to be the P-H bond that replaces a P-OH bond present in its biologically universal analogue, phosphate. Not surprisingly, phosphonates containing this P-H bonding are rarely found in nature. The mammalian toxicity of the phosphonate union is similar to that of phosphate and less than that of aspirin. It is readily oxidised to phosphate by soil microbes.

Root diseases had always been considered recalcitrant because while foliar sprays of conventional and systemic fungicides had protectant or even eradicator activity against stem and leaf infections, there was little or no therapeutic activity against root infections caused by Oomycetes. A significant advance was made with the release of the systemic phenylamide fungicide metalaxyl (Ridomil). Metalaxyl has "upward" or acropetal systemic mobility, and although it is effective against root infections when applied as a soil drench, it has no activity against root infections when applied as a foliar spray. This posed two problems, the first being that many Oomycetes are particularly important root pathogens, causing root rots and damping-off diseases in a wide range of hosts.

*Part 2 will describe other methods of management. One showing promise is a biological control using composted manures. Soil borne *Phytophthora* like *P. cinnamomi* find it difficult to survive when the soil is amended using composted chicken manure. Not surprisingly Proteaceae such as *Banksia grandis* and *B. spinulosa* do not like this form of compost but soil drenches of 150 ml/plant of 1.0g/l potassium phosphate gave excellent protection.

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The second problem was that although root drenches reduced disease, it is a wasteful method of fungicide application that releases much of the active ingredient into the soil ecosystem and water. In addition, it became apparent that soil micro-organisms rapidly degrade metalaxyl, reducing its persistence.

In 1977, Rhône-Poulenc released Aliette, a fungicide containing fosteyl-Al (aluminium tris-*O*-ethyl phosphonate). This chemical has activity against stem, leaf, and root diseases caused by Oomycete pathogens. Because of its unique properties, Aliette was quickly adopted in the fight against Oomycete pathogens. As a wettable powder (Aliette WP) it was used as a soil drench or foliar spray and became widely used for the control of *Phytophthora* diseases of pineapple and avocado, and against *Plasmopara viticola* on grapevine.

The unique "downward" as well as "upward" movement of phosphonates prompted attempts at controlling root rot of avocado by the novel technique of trunk injection. The success of these trials eventually led to the release of Rhône-Poulenc in 1988 of a soluble formulation of fosteyl-Al, Aliette CA, designed specifically for use in trunk injection.

It was recognised that fosteyl-Al is hydrolysed in plants to release the phosphonate anion. It was shown that it is the phosphonate anion that is primarily responsible for the activity of fosteyl-Al against Oomycetes, with perhaps some supplementary protectant effect from the aluminium ion. Rhône-Poulenc has never marketed straight phosphonate as a fungicide but instead, developed the ethyl phosphonate salts of aluminium, calcium, and sodium as Aliette, Aliette CA, and Nina, respectively.

Research in Australia, the USA and South Africa has used a partially neutralised solution of phosphorous acid (H_3PO_3) as a soil drench, foliar spray, or trunk injection for the control of the most serious disease affecting the avocado industry, root rot caused by *Phytophthora cinnamomi*. The excellent and durable control of root rot demonstrated in these trials resulted in a small Brisbane company, now known as UIM Agrochemicals (Aust.) Pty Ltd, to produce a formulation called m,d-KP(mono-, dipotassium phosphonate) for avocado growers at a price lower than that of Aliette. It was widely adopted as a means of controlling *P. cinnamomi*, first in avocado, then later in other crops. The annual cost to spray an avocado tree with a canopy diameter of 6 m with Aliette was \$A28, while injections of m,d-KP cost only \$A3.60.

Further development of the product in Australia has seen the registration of Fosject 200, Foli-R-Fos 200, Fos-4-Pine for the control of a number of diseases across a range of crops. Subsequent to an unsuccessful action by overseas interests Australia became the first market in which potassium phosphonate could be sold for use against Oomycete diseases of plants. There are now seven brands from a range of manufacturers available in Australia and other countries, registered for use against Oomycete diseases of avocado, pineapple, stone fruits, citrus, ornamentals, subterranean clover, grapevine, and cocoa.

Mode of Action and Selectivity

Phosphonates act against plant diseases through both direct and indirect effects on the pathogen. It seems that phosphonate disrupts phosphorus metabolism leading to fungistasis and subsequent activation of the host plants defence responses.

What is of immediate interest to horticulturists is that the presence of phosphonate in plants, at concentrations below those required to inhibit mycelial growth *in-vitro*, seriously disrupts the virulence of the pathogen. As a result, many phosphonate-treated plants respond to inoculation as if they were resistant, and their dynamic defence mechanisms are significantly enhanced. Thus the effectiveness of phosphonates against plant diseases caused by Oomycetes depends not only on the sensitivity of the pathogen to phosphonate but also on the resistance mechanisms of the host, combining to form a "complex mode of action". Furthermore, inherited characteristics and the physiological status of the host, as well as environmental factors, affect the distribution of phosphonate in plants and the concentrations confronting the pathogen at the infection court.

Because of this phosphonate-resistant pathogen isolates do not appear to have arisen after almost 20 years of use. A disadvantage of the complex mode of action is that results obtained with one host cultivar-pathogen combination cannot readily be extrapolated. Phosphonate also differs in its effectiveness against Oomycete pathogens in host cultivars or species, presumably because of differing capacities of the defence mechanisms in these hosts and differences in their ability to accumulate phosphonate at the infection court.

Phosphonate may affect mycorrhizal colonisation of plants. Soil drenches of fosteyl-Al have been found to inhibit root growth and subsequent mycorrhizal colonisation of seedlings in pot trials. Phosphonate has a similar effect. However, previous studies had shown that fosteyl-Al applied to mycorrhizal leek and lettuce seedlings stimulated mycorrhizal colonisation.

Translocation. The introduction of xenobiotics into the xylem results in their rapid transport to the leaf tissue. However, if translocation is limited to apoplastic movement regulated by physical factors such as root pressure and transpiration, xenobiotics tend to accumulate only in leaf apices and margins. By contrast, ambimobile xenobiotics such as phosphonate completely infuse the leaf tissue as well as stems and roots.

Persistence and Residues. Undoubtedly, the persistence of phosphonate in plant tissue contributes to its effectiveness as a fungicide. However, tissue concentrations of phosphonate decline with time, necessitating sequential applications of the fungicide to sustain critical concentrations and disease control. Phosphonate concentrations in the total plant system decline by: (1) dilution through plant growth; (2) removal as residues in plant products during harvesting; (3) losses in root exudates; and (4) loss as residues in falling leaves.

In most horticultural crops where phosphonate is used for the control of Oomycete diseases the economic product is the seed or fruit. During their development, particularly in the early stages of ontogeny, these organs are the strongest sinks for residue in the plant and may accumulate high levels of phosphonate relative to other plant organs. However, fruit from trees injected with phosphonate a few weeks before harvest were found to contain only traces of the fungicide.

High levels of phosphonate, up to 100 mg/kg fresh weight, can be found in cocoa beans from injected trees, but these residues disappear due to oxidation to phosphate during fermentation and roasting. Tasting panels of three major British chocolate manufacturers could detect no taints or flavour differences between chocolate made from beans taken from injected or uninjected trees.

Injection Technology

Trunk injection is occasionally used to apply nutrients, insecticides, antibiotics, and herbicides to trees. Gravity infusion and root infusion can be used but are far too slow to be of any practical value. Pressurised trunk injection using either air, spring, gas, or hydraulic compression to force the chemical into trees is more practical and cost-effective. A number of devices are now available.

The devices used by Australian avocado growers and Papua New Guinea cocoa growers to inject phosphonate into trees include the following:

1. A converted veterinary hypodermic syringe (50 ml capacity). Holes are drilled into the barrel and plunger of the syringe so that a locking pin can be inserted to maintain air pressure. A hole is drilled into the tree trunk, a polythene connection tube is inserted into the hole, and the tip of the syringe containing the required volume of chemical is forced into the connection tube, which expands and provides a seal.
2. A specially designed Chemject injector which contains a spring-loaded plunger and has a tapered screw nozzle.
3. A gas-powered gun manufactured in Dubbo, New South Wales, by Ag-Murf Engineering, powered by LP gas stored in a small, rechargeable, portable gas cylinder in a specially designed lightweight pack.
4. A hydraulic tree injector developed by Alstonville, New South Wales, avocado grower R. W. Rawlins. This highly effective, robust unit consists of a 5-L backpack reservoir, a hydraulic cylinder and lever, and a tapered nozzle with a non-return valve. ■

Smoke Germination

by Shauna Roche,
Kingsley Dixon and John Pate

A lead from South African botanists has enabled research staff at Kings Park and Botanic Garden, Western Australia, to uncover a completely new approach for germinating seed of conventional and recalcitrant native Australian species.

The smoke process has been successfully applied to germination of 70 species and 38 genera of native Australian plants. The process will be applicable to a wide range of Australian plants, particularly those which are fire or disturbance opportunists, such as *Epacridaceae*, *Stackhousia* or *Eriostemon*.

Development of a reliable propagation procedure for many species will add significantly to the commercial development of Australian species for cut-flower production for export and amenity horticulture. There is potential for crop-managed production to be increased by \$2–5 million using this smoke technology.

Environmental concerns regarding the sustainability and ethics of wild picking may be alleviated by the application of this new germination process which offers a cost-effective method for greenstock production. In addition, the mining industry will be able to better restore degraded lands and bushland regenerators can now expect to replant with a larger suite of species than has been possible before.

Germination of Proteaceae using smoke

Though many Proteaceae grow readily from seed, a number of *Grevillea*, *Conospermum* and assorted other groups have proven difficult to germinate yet the seed appears to be viable. Research by staff at Kings Park and Botanic Garden indicates that for a number of *Grevillea* species, smoke response can be immediate even with fresh seed e.g., *Grevillea polybotrya*, *G. quercifolia* and *G. wilsonii*. For other *Grevillea* (including the rare *Grevillea scapigera* from the Corrigin district), fresh seed is unable to be stimulated to germinate using smoke, however seed that has been aged in soil for a year or more becomes highly responsive to smoke. Other Proteaceae with positive response to smoke include *Hakea corymbosa*, *Isopogon ceratophyllus* and *Petrophile* spp. For all Proteaceae, smoke can be applied either directly to the seed or seed can be sown into punnets and the seed tray surface smoked in a tent with aerosol smoke from combustion of a range of green and dry material. The smoking is usually done for up to one hour for either seed or seed tray situations.

The use of smoke will facilitate improved habitat management and conservation of rare and endangered species. The process also provides the first ever option to controlled burning for the maintenance of species which are dependant on fire for reproduction.

Other Wildflowers for smoke germination

For horticulturally significant taxa in *Verticordia*, *Conospermum*, *Eriostemon*, *Hybanthus*, *Lechenaultia*, *Pimelea*, *Stirlingia*, *Geleznowia* and four species of Epacridaceae, smoke provides a ready means for propagation.

Seed aging as a method for improving smoke responsiveness, has been clearly demonstrated by research in Kings Park for a wide range of Australian plants, most prominently being many of the large fruited Epacridaceae. *Conospermum* which has traditionally been very difficult to germinate is highly responsive both with fresh or aged seed. It appears that for many species, particularly those with very small seeds, some suppressive action is likely at very high levels of smoke. *Persoonia*, has so far proven to be unresponsive to smoke even when seed has been aged for sometime.

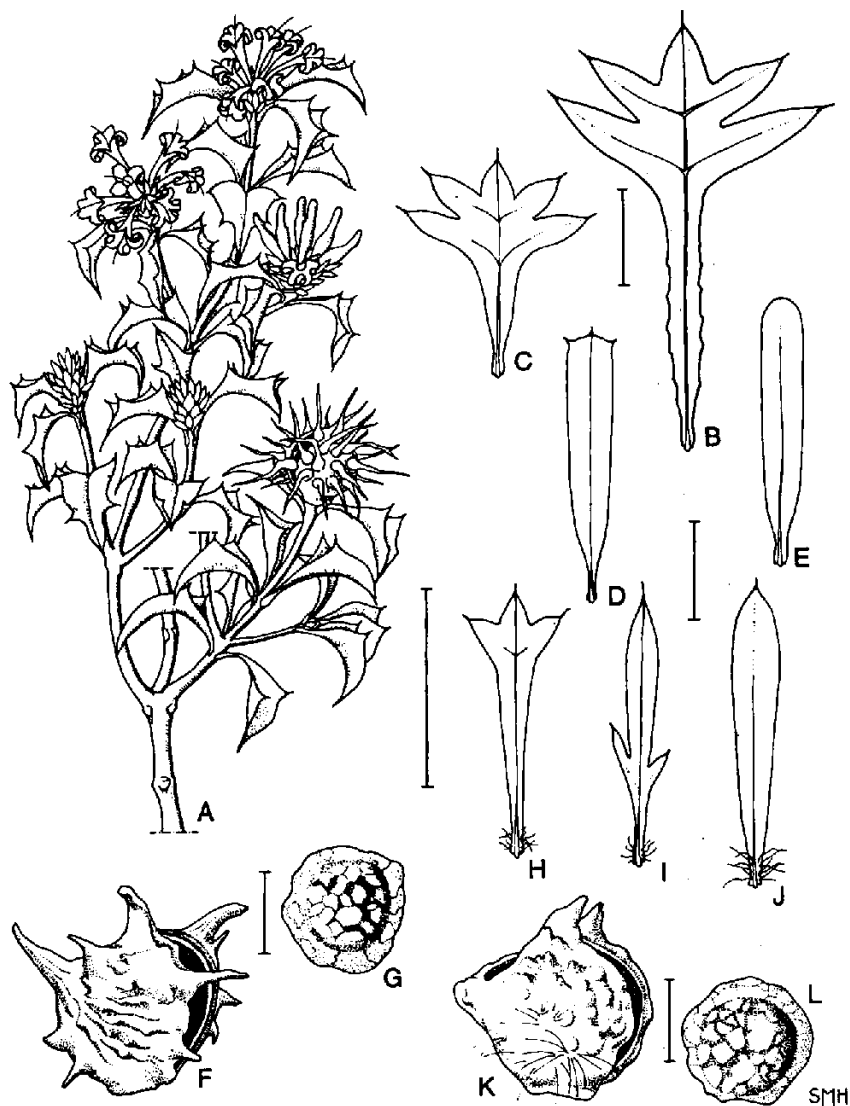
The process of smoking is quite simple

A 100 litre drum is fitted with a lid, and an air inlet (bottom of drum) and air outlet (top of drum) are attached. The outlet is 30 mm of piping up to 1.2 m long which is attached to tubing for conducting smoke into a small, "Telecom"-like tent. Seed trays are placed in the tent and a combination of fresh and dry native material (type of species is not important) is combusted with just sufficient air supplied to allow combustion but not flaming. The smoke is cooled by keeping the outlet pipe moist and cool.

Trays with seeds already sown or naked seed are smoked in the tent for about one hour. The trays or seeds are then treated as normal seed for propagation, with watering maintained at a minimum to prevent wash-through of the smoke factor. Germination of most species occurs four to six weeks later.

Smoke Germination

Since the first announcement of this method many readers have developed their own techniques using readily available facilities. Will these readers please send to me a short note of their system and the results they have achieved—Editor.



Drawn by S. House as in *Flora of Australia*, Volume 16.

Honeysuckle that do not have leaves with spiny margins.

Lambertia ilicifolia, A with holly-like leaves, flowers 10–12 mm long.

Lambertia echinata, B and C mature leaves, D–E juvenile leaves, F fruit, G seed.

Lambertia fairhallii H–J leaf variation, K fruit, L seed.

Round Leaf Honeysuckle

Taken from a report by Leigh Sage and Byron B Lamont

Lambertia orbifolia is a declared rare species that occurs in scattered and remote locations in the extreme south west of Western Australia. Populations selected for study were in the Scott River Plains, Adelaide Springs, Snake Springs and in the Albany region at Narrikup.

The Narrikup population is heavily infected with canker which is gradually killing the plants. Snake Springs has a slight canker infection, while the Adelaide Springs population seems to be uninfected. Dieback (*Phytophthora* spp.) was not present at any of the three populations. The level of weed invasion is greatest at Adelaide Springs, though not extensive for any of the populations.

Fire-induced germination at Adelaide Springs has resulted in seedlings making up over 86% of the population, while the majority of individuals at Snake Springs and Narrikup are adults. No burnt plants survived the fire, so that *L. orbifolia* can be classified as a non-sprouter. Soil and litter samples showed that the largest numbers of seeds were found in the litter layer with virtually no seeds retrieved from in the soil layer. No ants were observed removing seeds from the ground. It appears that seeds of *L. orbifolia* simply fall to the ground where they remain until stimulated to germinate by fire. Fruit set was virtually identical at all three populations.

Lambertia orbifolia was gazetted as rare by the Government of Western Australia in 1980 (Wrigley and Fagg 1989). It was first named in 1964 by the government botanist of the time Charles Gardner. The specific name refers to round leaves: *orbis* latin for circle and *folia* for leaves. The species is considered to flower most of the year but peaks in May–July and in January–February. The shrub grows on sandy lateritic and deep sandy soils in winter wet areas to a height of 2–3 m, and occasionally as high as 5 m. It has hairy branches with broad almost round leaves 20–50 mm long and 20–40 mm across. The orange-red florets occur in groups of four to six surrounded by small bracts terminally and in the upper leaf axils. The tubular flowers are usually 50 mm long and hairy on the exterior. The follicles are usually 10 mm long, smooth, brown/grey in colour when mature and possessing a short beak.

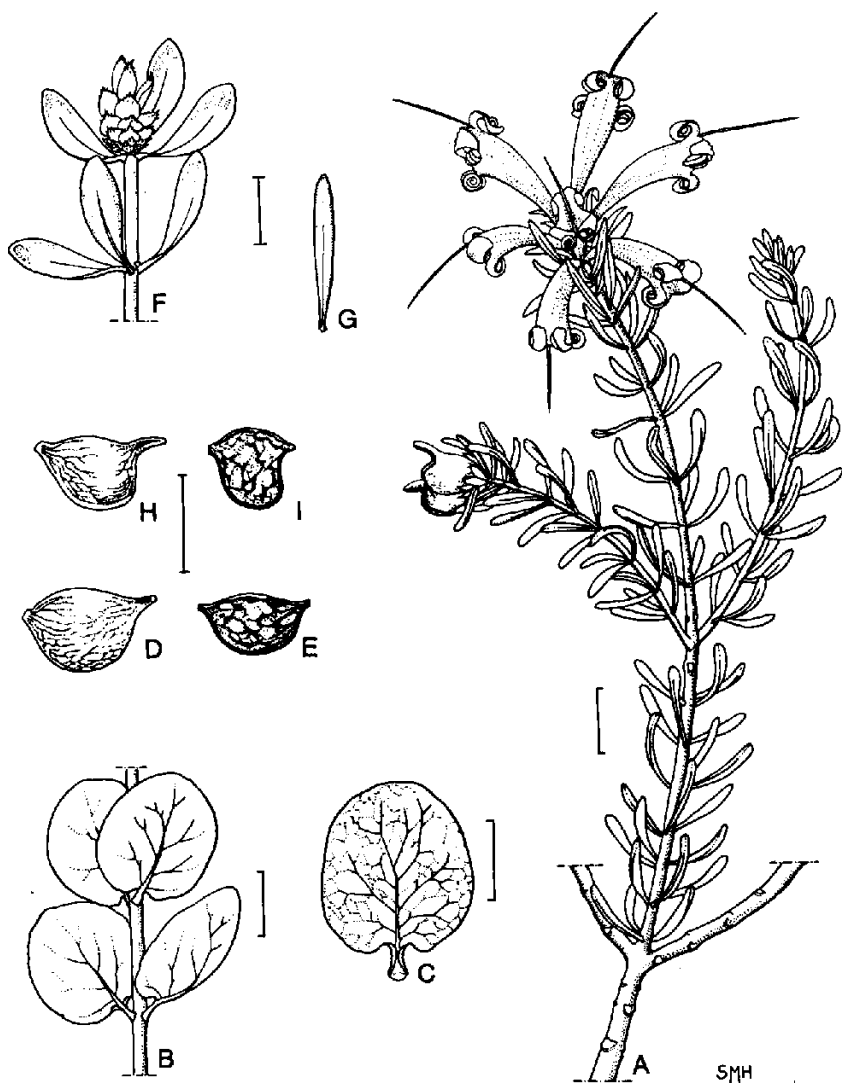
Reserves

Populations are fragmented and none are found on any reserve. Suitable reserves should be formed. Replicate reserves should be no greater than 15 km apart, to assist with outbreeding and thus genetic variability. Viable populations, relatively disease free are less than 15 km apart at Adelaide Springs and Snake Springs. Reserving, or an agreement with the property owners at these sites and the Scott River area to control the extent of weed invasion, the spread of disease, damage by cattle and enable the fire regime to be controlled, is being recommended.

Cultivation of this species for commercial purposes is recommended. The plants are very attractive and would be valuable as an ornamental garden plant and as it is a large shrub especially in public spaces. ■



Lambertia orbifolia



Honeysuckle that do not have pungent points on the ends of the leaves. Leaves linear 1–1.5 mm wide margins revolute.

Lambertia ericifolia **A** flowering branch with a bunch of flowers and a fruit, see page 335. Leaves spatulate (wider near end) 3–7 mm wide.

Lambertia inermis **F** arrangement of elliptic leaves (may be narrower as **G**), on a stem with overwintering bracts; **H**, the fruit and **I**, the seed. See page 335. Leaves rounded 15–20 mm dia.

Lambertia orbifolia, **B**, arrangement of leaves as in **C**; **D** the fruit, **E**, seed. See page 372.

Conserving Native Grasslands

Australia's Most Threatened Ecosystems — southeastern lowland native grasslands*

by Jamie Kirkpatrick, Keith McDougall and Michael Hyde

What we need to do! Maintain or improve the overall condition of any remnant by reducing exotic species cover and maintaining or increasing native species richness and cover. If it is now a good example of natural grassland then its management over the last 100 years is a guide to its continuing conservation. This may have included fire, grazing, mowing, slashing and mechanical disturbance all of which could be continued. Supplement with hand weeding, planting or sowing and herbicide treatment. The latter option should be used with care as herbicides may badly affect native invertebrates. In some cases the lower plant crust that usually covers the inter-tussock spaces will have to be reintroduced through the use of slurry or small transplants.

The most imminent threat to the biological diversity of grassland is the **extinction of rare and threatened species and genotypes**. Provide conditions to facilitate their survival. This requires careful observation of the conditions in which these species regenerate and thrive. Reintroductions or enhancement plantings must be considered. With competent advice it may be necessary to transport them from sites that are to be developed to remnants in which they are not presently found, but which were likely to have supported them in the past.

Significant native grassland remnants occur on road and rail reserve. These remnants in western Victoria are burnt for fire protection by volunteer brigades who should be encouraged to continue their management regimes, and perhaps improve them in some cases. Unfortunately herbicides and ploughing are being preferred to burning on some roadsides.

Communities Dominated by Tussock Grasses (*Poa* species)

1. Tussock Grass-Spear Grass-Red-leg Grass Monaro Basalt Grassland

A dense tussock grassland. Tussock Grass (*Poa sieberiana*)-Spear Grass (*Stipa scabra*)-Red-leg Grass (*Botriochloa macra*) with Whitetop (*Danthonia caespitosa*) is widespread in highly degraded form on the heavy clay soils of the basalt paddocks of the Monaro, but is absent from the valley bottoms. The community can be seen in Numeralla Cemetery in the Australian Capital Territory and on the Ravensworth TSR 23 km south of Cooma in New South Wales. Other characteristic species include Woodruff (*Asperula conferta*), Common Everlasting (*Chrysocephalum apiculatum*), Sheep's-burr (*Acaena ovina*), Bindweed (*Convolvulus erubescens*) and the Tufted Bluebell (*Wahlenbergia communis*).

*This important small book is available from Surrey Beatty & Sons, 43 Rickard Rd, Chipping Norton, NSW 2170 for \$16.95 plus \$3.70 postage. The 100 pages present a vital segment of the threatened flora of our continent. It is of little value to those who want to know more about our grassland plants but for those concerned with its conservation or those property owners who would like to conserve some of this unique habitat, it is a very valuable reference. If a grassland remnant has survived there is no need to change the management practices that has preserved it except for "fine tuning" and possibly replanting or seeding. The book is a guide to the grassland types of southeastern Australia, one group, the community dominated by Tussock Grasses is reproduced from the book as its guide to content. Other groups are: Communities Dominated by Wallaby Grasses, by Mat Rushes, by Porcupine Grass and by Kangaroo Grass.

2. Tussock Grass-Sedge-Rush Monaro Grassland (M5)

Large, tall, dense to mid-dense tussocks of Tussock Grass (*Poa sieberiana*), sedges (*Carex appressa*) and rushes (*Juncus australis*, *J. filicaulis*) dominate and characterise this community of damp and nutrient-rich soils. The community is reserved in the Kosciuszko and Namadgi National Parks. Outside these parks it is usually in poor condition.

3. Tussock Grass-Sagg-Buzzies Tasmanian Valley Grassland (T1)

The community characteristically occurs on the better-drained parts of the flat floors of sandstone valleys in the Midlands of Tasmania. It consists of dense stands dominated by tall tussocks of Tussock Grass (*Poa labillardieri*) and Sagg (*Lomandra longifolia*). Other characteristic species include the grass, *Dichelachne crinita*, Wallaby Grass (*Danthonia* spp.), Buzzies (*Acaena novae-zelandiae*) and Oxalis (*Oxalis perenans*).

4. Tussock Grass-Weeping Grass-Flat Daisy Tasmanian Valley Grassland (T2)

The community typically occurs on black or red clay soils on dolerite on well-drained sites in valley bottoms. It is dominated by sparse tussocks of Tussock Grass (*Poa labillardieri*). These are interspaced with a sward of grasses and herbs. Characteristic species include Sagg (*Lomandra longifolia*), Wallaby Grass (*Danthonia* spp.), Kangaroo Grass (*Themeda triandra*), rushes (*Juncus* spp.), Sheep's Burr (*Acaena echinata*), Weeping Grass (*Microlaena stipoides*) and Flat Daisy (*Solenogyne dominii*). The community is rich in naturally rare or threatened species including Mr Curly Sedge (*Carex tasmanica*), Clover Glycine (*Glycine latrobeana*), Obscure Bog-rush (*Schoenus absconditus*) and Gunn's Mignonette (*Stackhousia gunnii*).

5. Tussock Grass-Rush-Matted St John's Wort — Tasmanian Flood Grassland (T3)

Tussock Grass-Rush-Matted St John's Wort — Tasmanian Flood Plain Grassland is found on alluvial flats in Tasmania, where it is usually heavily grazed and subject to invasion by Gorse (*Ulex europaeus*) and Willows (*Salix alba*). Large tussocks of Tussock Grass (*Poa labillardieri*) form a dense dominant stratum in this community. Characteristic species include a sedge (*Carex iynx*), Willow-herb (*Epilobium* spp.), rushes (*Juncus* spp.), Oxalis (*Oxalis perennans*) and Matted St John's Wort (*Hypericum japonicum*). The nationally rare Mr Curly Sedge (*Carex tasmanica*) occurs in this community.

6. Tussock Grass, Native Cranberry-Flax Lily — Tasmanian Rock Outcrop Grassland

This is a Tasmanian community characteristically found on shallow brown sandy clay loam soils around dolerite rock outcrops in forests dominated by Peppermints (*Eucalyptus pulchella*, *E. amygdalina*) or White Gums (*Eucalyptus viminalis*). Tussock Grass (*Poa rodwayi*) dominates a closed low sward of grasses, herbs and prostrate shrubs. Other characteristic species include Spear Grass (*Stipa* spp.), Weeping Grass (*Microlaena stipoides*), Native Cranberry (*Astroloma humifusum*), Creeping Bossiaea (*Bossiaea prostrata*) and Flax Lily (*Dianella revoluta*). The nationally threatened prostrate shrub, *Spyridium obcordatum*, occurs in the best example of this community. Tiny areas of this inadequately reserved community are found in Freycinet and Maria Island National Parks. An area of Crown Land to the west of Port Sorell on the north coast presents the best opportunity for further reservation.



A threatened ecosystem

A herb-rich grassland in Western Victoria with Magenta Stork's-bill, *Geranium rodneyanum*, and Paper Daisy, *Leucochrysum albicans*. Photograph by Keith McDougall. The front cover of Australia's Most Threatened Ecosystems — southeastern lowland native grasslands

Australian Grass and Sedge Study Group has been formed. Its aims include conservation and management of grassland areas and the use of sedges and grasses in landscaping. Enquiries through your SGAP Region secretary as listed inside our rear cover.

A Field Guide to the Wildflowers of the West Coast Hills Region

The Darling Range Branch of the Western Australian Wildflower Society has recently produced an illustrated field guide. The guide incorporates a structured user-friendly key that allows interested people to identify the flowering plants of Perth's unspoilt backdrop, the Darling Range. 256 pages, in A5 softback format, it is illustrated with 289 colour photographs. The plant species are divided into broad sections based on observable size, growth habit, woody or herbaceous, petal number, colour and arrangement, etc. There is also a flowering calendar section to aid identification on a month-by-month basis.

The book is available for \$19.95 per copy including postage from Quality Publishing Australia, 227A Charles Street, North Perth, WA 6006.

Can You Successfully Graft Plants?

Australia needs you

There is an important future in the grafting of Australian Plants for general horticulture and landscaping. This issue feature the Fire Wheel Tree a spectacle in full flower. But what a large tree it becomes. By grafting a mature branchlet ready for flowering, onto a vigorous seedling, you can have a flowering spectacle on a bush 1–2 m high.

The opportunities are as endless and the magnificent Australian flowering trees. Examples are the *Xanthostemon* (either Golden Panda or the red flowering species), *Brachychiton*, *Alloxylon*, *Castanospermum* and many of the large flowering shrubs. We have excellent grafters such as Doug McKenzie, Merv Hodge, David Mason, Tony Blackmore, etc. but we need many more. They need to be located where the suitable material is available.

The nation needs you to dress our cities for the celebration years of 2000 and 2001. Here in Sydney where we will be holding the Olympic Games is a magnificent area with outstanding landscaping that is supposed to feature the Australian flora. The way things are everything will be a spectacle we can all be proud of but the Australian plants on show will be a disaster. The International Garden Festival allotted to Sydney in 2000/2001 will now be known as Planet Earth. We need spectacular live flowering plants by the hundreds. Who can help?

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. (074) 46-7088.

Wildflower Nurseries in New South Wales

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

Bryants Native Plant Nursery — Cosy Camp Road, Bex Hill, N.S.W. 2480. Tel. (066) 28-4323. 15 kms north of Lismore. Open 7 days (from 11 a.m. on Sundays). Extensive range of trees, shrubs, groundcovers, rockery, grafted Grevilleas, rainforest plants. Excellent quality and service.

Dealbata (cold climate) Aust. Plant Nursery — off Bloomfield St., Dalgety, 2630. Tel. (064) 56-5043. Specializing in alpine and dry Monaro plants — grown from locally collected material. Phone to arrange visit.

Floralands — Parry's Nurseries Pty. Ltd. Kariong via Gosford, 2250. Tel. (043) 40-1142. Preservation by cultivation. Send \$1.50 for descriptive catalogue.

Kentlyn Native Plants — 206 George's River Rd., Campbelltown, 2560. Tel. (046) 25-1583. Open 7 days.

Mudgee Native Tree Nursery — 548 Henry Lawson Drive, Mudgee, 2850. Growers of frost and drought tubestock and bagstock suitable for inland NSW. Open 7 days. Tel. (063) 73-3756, Fax (063) 73-3754.

Newcastle Wildflower Nursery — 45 Pacific Hwy, Bennetts Green 2290. Tel. (049) 48-8576. 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.

Wariapendi Farm Nursery — Church Ave., Colo Vale (7 km north of Mittagong off F5, take Colo Vale exit). Tel. (048) 89-4327, Fax (048) 89-4092. Growers of frost hardy natives from tubestock to advanced. 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. (046) 84-1112.

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

Anne and Colin Dealtry — Lot 2, Trevilla Rd, One Tree Hill, SA 5114. Open on the first two weekends each month, 10 a.m.–4 p.m., or by appointment. Tel. (08) 8280-7079.

Brenton Tucker Native Plants and Carawatha Garden — off Placid Estates Rd, Wellington East via Tailern Bend. Tel. (085) 72-7104. Wide range of tubestock and advanced plants. Extensive display gardens and picnic areas. Open w/ends and public holidays September to November and April to June — 10.00 a.m.–4.00 p.m.

Wildflower Nurseries in Tasmania

Plants of Tasmania Nursery — 65 Hall St., Ridgeway 7054. SAE catalogue. (03) 6239-1583. Closed Tue & Wed.

Wildflower Nurseries in Victoria

Bushland Flora — Indigenous plants of Melbourne. Ph. (03) 9736-4364 for stocklist.

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 Maroondah Highway, Ringwood, 3134. Ph. (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.

Western Australian Wildflower Society — P.O. Box 64, Nedlands 6009. A wide selection of Western Australian seeds is available at \$1.50 per packet, plus postage of 45¢ for a number of packets. Send for a catalogue for \$2.00 plus 80¢ postage. A huge range of seeds at a price you can afford expertly collected, labelled and packed. A book "Hints on Growing..." 40 pages, \$3.80 posted.

STUDY GROUPS — These comprise society members specialising in a particular group of plants. They operate mainly by correspondence exchanging experiences, plants and seed. They each have a very impressive newsletter for members. Two groups offer the following to all:

Banksia Study Group — The Banksia Study Group has just published its Report No. 10 which is now available @ \$3.00 plus 85c/95c postage. It covers a range of topics from local trials to a thorough article on the propagation of banksias. Previous issues also available are No. 7 @ \$6.00 and No. 9 @ \$5.00 each plus 95c postage, all available from Trevor Blake, 22 Vista Ave., Ringwood East, Vic., 3135.

Dryandra Occasional Publication 1 — With the generous assistance of Alex George the up to 30 page booklet will include details and sketches of the Dryandra flower head and leaf shapes and margins. Available from Tony Cavanagh, 16 Woodlands Drive, Ocean Grove, Vic. 3226 for \$5 plus \$3.70 postage.

"Australian Plants", The Australian Flora Periodical

Past issues are available in volumes 4-10/11, each volume is bound and cased, beautifully presented with green vinyl covering and gold lettering for \$21.00, plus \$5.00 post. Volumes 16 and 17 will not be available bound. Volumes 12, 13, 14 and 15 are available only from The Editor, Australian Plants, 860 Henry Lawson Drive, Picnic Point 2213, for \$40 each plus \$6 postage.

Binders to hold the eight separate issues of Australian Plants in a volume are \$5.50, plus \$3 post.

Other Books Published by the Society:

"Australian Indigenous Orchids", Revised Edition, by A. W. Dockrill. 2 vols. \$84 each including post.

"Australian Plant Genera" by J. A. Baines. \$9, \$5 post.

"Cradle of Incense" by G. W. Althofer. A delightful book on Mint Bushes. The Genus *Prostanthera*. \$8, \$3 post.

"Friends and Foes in your Garden" by D. Hockings. The best guide on pest and disease control. \$20, \$6 post.

"Language of Botany" by C. N. Debenham. An outstanding reference to botanical language. \$16.50, \$3 post.

Book Supply Mail Service. For back issues of *Australian Plants*, bound volumes and binders, send orders to P.O. Box 410, Padstow, NSW 2211. Other book orders to Florilegium, P.O. Box 644, Rozelle, NSW 2039, phone (02) 9555 5899 or fax (02) 9818 4409, at prices quoted; a discount of 10% for orders in excess of \$50.00.

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Australian flowers went to Atlanta
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