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Answers to the query in the last issue have indicated a very wide appreciation of the content of recent issues of Australian Plants. However, there was a desire that we continue to print articles on practical cultivation, even increase the number if possible. This has been our policy for 26 years and there have been numerous appeals to readers to send in reports. This is not easy for most. Fortunately our years of work, our hundreds of simply-written articles, our initiative in creating Study Groups, The Australian Flora Foundation, etc, have paid off. Those who stuck with us, began as bamboozled beginners, acknowledged that the only sane thing to do was to accept the generic name as the name to be used and so got used to using them and are now writing for us. Some have got a little technical themselves, but their reports are invaluable. See the article opposite.

The Myrtles

One of the "Tea-trees", *Leptospermum* (see page 225) belongs to the large family of Myrtles. We are preparing an issue on the myrtles but need comments by readers on their experience in cultivation of these plants, and we especially need good colour slides. Who will help? Not just *Leptospermum* but the whole lot: *Kunzea*, *Agonis*, *Sinoga*, *Micromyrtus*, *Thryptomene*, *Corynanthera*, *Malleostemon*, *Humalosperrum*, *Pericalymma*, *Calothamnus*, etc.

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COVER PLATE

Banksia integrifolia

Photography by Lois Sourry

The coastal *Banksia* has a number of varieties as described in the article on page 202. This is the form, variety *integrifolia*. Everyone can have a *Banksia* tree in their garden.

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Eremophila *Boronia*



Propagation

by Tony Clarke in South Australia

Eremophila brevifolia is often confused with *E. lehmanniana* var *dentata*. *E. brevifolia* has green stems with parallel bundles of nerves (striate), leaves are small (1 cm × 1 cm), entire or toothed margins, small oil glands appear as raised dots on underside. Flowers are white or pale mauve. Plants propagate readily from tip cuttings taken at any time of the year. Flowers and buds should be removed or botrytis attack may result. We use Seradix 2 (Indole Butyric Acid 3000 parts per million) and place cuttings in coarse quartzite sand. Strike rate is close to 100% in 14 to 21 days (bottom heat 25°C in winter, no bottom heat spring, summer, autumn). Plants are fast growing, grow on most soils except wet sites and are generally reliable over most of southern Australia. They are inclined to become leggy and sparse underneath unless pruned very hard occasionally.

Eremophila lehmanniana differs in having velvety stems, circular in cross section, and leaves which lack oil glands. There are other differences but these are the most obvious to the casual observer.

Propagation requirements and growth habit are very similar to *E. brevifolia*.

Eremophila psilocalyx is a large self-shaping shrub to 3 m × 2 m. Flowers are white or pale pink with an ornamental calyx. It grows well on a variety of soil types including sand, clay or limestone and is untouched by frost in SA. Grown mainly by enthusiasts at present. Propagation from cuttings can be very slow using the usual methods. Plants will strike but may take six months to do so. Cuttings can be induced to strike more quickly by selecting only very fresh new growth, then roughening the area of stem to be treated by rubbing with medium sand-paper or steel wool. This must not be done so as to strip bark back to the cambium or cuttings die quickly. *E. psilocalyx* has a waxy coating on stems and branches which inhibits penetration of rooting hormones. With no hormone penetration cuttings are very slow to form roots.

Boronia inornata is a small shrub found growing in neutral, alkaline sandy mallee soils in SA, Vic, WA. Plants are twiggy with very small true leaves and masses of showy pink flowers late winter, spring and sporadically throughout the year. *Boronia inornata* is much admired by native plant enthusiasts in drier areas but to this stage has proved difficult to propagate. Some success has been reported using green seed but cuttings are extremely difficult. Cuttings usually linger in trays for a while and then eventually die after several months. Seradix 3 (8000 IBA) does not even induce callusing on young tips. Using our own preparations (13,500 and 17,000 IBA) we have rooted small numbers when these powders are combined with overnight soaks of cuttings in five drops of Formula 20 to 500 ml of water. Formula 20 contains Naphthalene Acetic Acid, Indole Acetic Acid and various B group vitamins, all of which induce root formation on plants. Cutting problems may stem from the bark on the stems being too thick for the hormone to penetrate or the chemistry of the plant not responding to usual combinations of hormones tried. ■



Eremophila bowmanii △

▽ *Boronia pencillata*





Boronia inornata (front) and ***Eremophila psilocalyx*** (rear)

Photography by Tony Clarke

The semi-wild section of Ken Warne's garden at Owen, South Australia in late July. The soil is a natural drift, silicaceous with organic matter and a pH about neutral. The annual rainfall is approx. 400 mm. In the centre foreground are two plants of *Boronia inornata* in front of a large plant of *Eremophila psilocalyx*, also known as *Eremophila pachyphylla*.

Eremophila bowmanii (opposite top)

Photography by Neil Marriott

A bush half to one metre high from the southwest of Queensland, the pale to deep mauve flowers may be 2 cm across and 3 cm long. The foliage can be quite variable, green to grey leaves quite narrow to broad. The species grafts quite well on to *Myoporum*. An example of an *Eremophila* flower.

Boronia pencillata (opposite bottom)

Photography by C. Garrett

A typical *Boronia* flower captured by the photographer to show the details of the four petalled flower. It was not possible to get a good slide of *Boronia inornata*, who has one?

When preparing cuttings of any species I recommend hormone treatment should be applied to the full length of the stem to be inserted into the cutting medium. This is contrary to what is recommended by most grower's manuals but I have very good reasons for doing it. Plants like *Correa* have long spaces between the nodes on stems and usually only make roots at the nodes. In a cutting with say two nodes in the medium treated only on the tip, roots form only on the bottom node. Assuming a situation arises where the cutting medium may be too wet near the base for long periods, oxygen is excluded and root formation is inhibited. The hormone is prevented from forming roots and cuttings are slow to strike.

Consider a cutting treated full length in the same situation. Roots will form at the surface and later, when the plant is tubed, may also form at the bottom node. If all goes well and roots are formed at the original cutting on the bottom node, when the plant is tubed root growth will be all at the bottom of the tube. If tubed with the root system closer to the surface an unstable plant results.

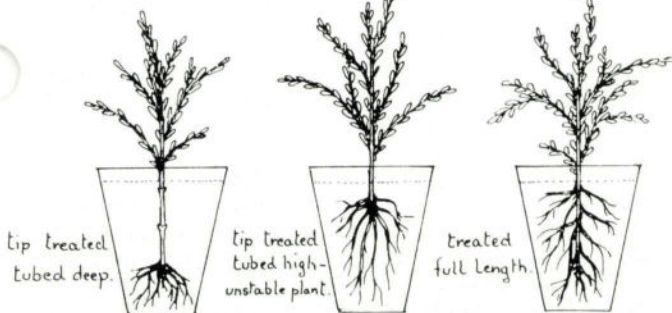
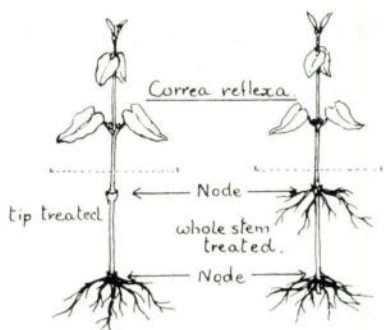
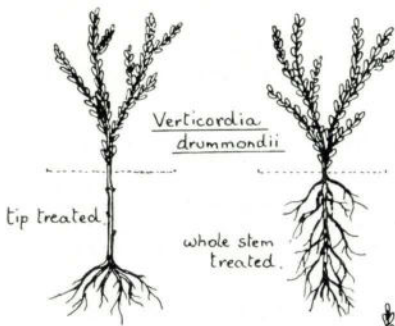
With some species such as *Hibbertia scandens*, root formation is continuous up the stem and very much like seedling roots. These make excellent fast growing plants. Experiments using various hormone strengths on the same species produces some interesting results. In practice a lot of combinations will produce a root system. If the hormone used is too weak, cuttings are very slow to root. The longer they take to root, the longer they are exposed to potential attack by pathogenic fungi. Once plants have rooted and are tubed into a growing mix, and start active growth, they are able to resist most pathogens.

Hormone treatments as they are increased produce threadlike roots with no stem swelling. Higher concentrations produce slight stem swelling followed by thick strong roots. Higher concentrations again can cause over-callusing and still higher concentrations cause the bark to separate from the cambium and subsequent death of cuttings. We use hormone strengths from 1000 P.P.M. IBA to 17,000 P.P.M. I make a lot of my own combinations and recently used IBA 17,000 P.P.M. on *Daviesia epyphylla*: 17,000 P.P.M. produced about 40% strike, 13,000 produced about 10% strike, possibly a higher concentration say about 22,000 P.P.M., may have induced a higher strike rate. *Verticordia grandis* callused at 8000 P.P.M. on 80% of plants. After tubing these all produced roots. *V. grandis*, at 13,500 P.P.M., produced 100% strike. I'd like to grow more of these but material is very scarce.

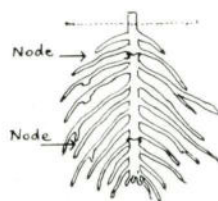
Tubing

Some growers fill tubes first, then make a hole, drop in the plant and firm soil around roots. Plants treated this way have fine roots bent up, which later grow down and form kinked root systems. When planted out these plants suffer a reduced lifespan similar to pot bound plants and are often subject to windthrow.

We prefer to hold the plant to one side and fill downwards thereby creating a straight root system which grows on strongly. ■

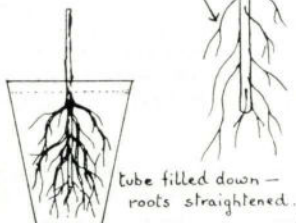
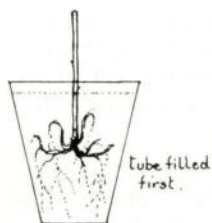


Strong fleshy roots similar to seedlings.



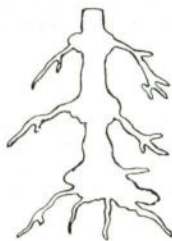
Hormone too weak

threadlike roots.



Hormone right strong fleshy roots.

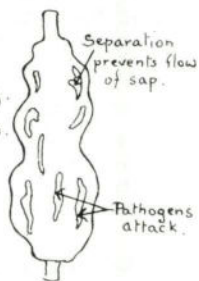
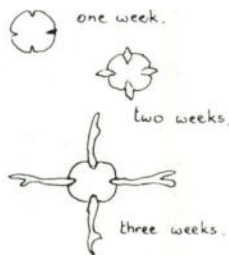
Hormone too strong over callousing.



Hormone much too strong. bark separates from cambium.

After tubing roots form from callous. Callous a good source for tissue culture.

Stem sections Hibbertia scandens.



Kangaroo Paw

by G. Motum*, I. A. Stewart* and P. B. Goodwin*

A Hybridisation
and Breeding Programme

*An extensive interspecific breeding programme involving six species of Kangaroo Paw was initiated in 1981 at The University of Sydney. Hybrids between *A. flavidus* and *A. humilis* have proven to be of particular interest. A number of compact, floriferous hybrids have been produced in a range of colours and with extended flowering times. They show considerable potential as flowering pot plants and/or cut flowers. Their evaluation under field and pot culture is now in progress. Propagation of the most interesting lines is being undertaken using tissue culture techniques as well as rhizome division.

The first reported hybridisation of Kangaroo Paws was carried out by Dr K. Finlay in the late 1950's at the University of Western Australia (Grieve and Marchant 1963). He obtained viable seed from crosses of *Anigozanthos manglesii* x *A. humilis* and *A. viridis* x *A. flavidus*.

Oliver (1971) carried out Kangaroo Paw hybridisation of *Anigozanthos manglesii*, *A. viridis* and *A. pulcherrimus* with *A. flavidus* prior to 1971. In 1979 Hopper reported the production of 39 different kinds of interspecific hybrids. A common objective of these breeders was to transfer the vigour, hardiness and disease resistance of *A. flavidus* to species with more spectacular flowers but which were less reliable in cultivation. In Hopper's hybridisation programme *A. flavidus* was crossed with *A. onycis*, *A. rufus*, *A. pulcherrimus*, *A. preissii*, *A. manglesii*, *A. gabrielae*, *A. kalbarriensis*, *A. bicolor* and *A. humilis*. A number of Hopper's hybrids e.g. *A. flavidus* x *A. preissii* (Regal Claw), *A. flavidus* x *A. rufus* (Red Cross), *A. flavidus* x *A. onycis* (Dwarf Delight), *A. flavidus* x *A. pulcherrimus* and *A. flavidus* x *A. manglesii* have shown superior vigour and flower production compared to the non-*A. flavidus* parent. With the aid of plant tissue culture techniques for rapid multiplication these sterile hybrids have become available in commercial quantities. These hybrids have proven to be useful in amenity horticulture and have allowed the expansion of commercial cultivation of Kangaroo Paws as cut flowers, however some of the new hybrid releases (e.g. 'Dwarf Delight') have proven to be susceptible to fungal leaf diseases (e.g. ink spot) caused by *Alternaria* sp.

With the expansion of the Australian Wildflower Industry and the establishment of tissue culture techniques for multiplying Kangaroo Paws, interest in the production of *Anigozanthos* hybrids has grown. In recent years breeding has been carried out on a large scale e.g. by Mervyn Turner (1984) of Victoria.

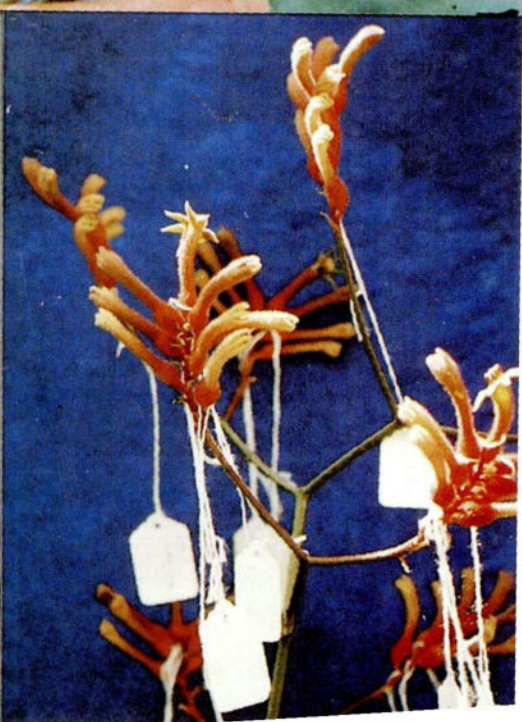
Within species of *Anigozanthos*, variability exists in flower colour and number, stem length, flowering times and resistance to disease. Selection of superior clones of commercially useful species is being integrated into breeding programmes. There is scope for future work by plant breeders in this area.

Acknowledgements

We would like to thank Mervyn Turner for the supply of superior selected clones of all six species, in particular selected colour forms of *A. flavidus*, for this experiment. We would also like to acknowledge the work carried out by Ivan Desailley, George Novak, Mike Bennell and Jill Lawson in relation to this project. This research was supported by a grant from the NSW Horticultural Stock and Nurseries Act.

Hybrid Kangaroo Paws (opposite)

Some of the hybrid Kangaroo Paws produced so far and two of the species in the trial.



All species of Kangaroo Paw are pollinated by birds (honeyeater, western silver eye) in the wild and for controlled hybridisation the flowers must be protected from the natural pollinating vectors. Most breeding work is carried out in an enclosed greenhouse. *A. flavidus* is known to be self-fertile and therefore it has usually been used as a pollen parent. Emasculation of the female plant had been found to be unnecessary in most cases (Oliver 1971).

The aim of the current breeding programme was to produce hybrids of superior quality which could be used either as cut flowers or pot plants. Desired features are, a) disease resistance, b) prolific flowering, c) vigour under cultivation, d) new and varied colours or forms, e) long flowering period, f) fast to flower.

Materials and Methods

An extensive collection of species, colour forms within species, and interspecific hybrids was made in 1981 for use in the hybridisation programme. Hand pollinations were carried out by I. A. Stewart in a glasshouse from September-December, 1981. The female parents were not emasculated. The following crosses were made:

- | | | | |
|-------------------------|----------------------------------|------------------------------|--------------------------------|
| 1. <i>A. preissii</i> ♀ | x <i>A. viridis</i> ♂ | 3. <i>A. manglesii</i> ♀ | x <i>A. viridis</i> ♂ |
| | x <i>A. manglesii</i> R/G | R/G | x <i>A. bicolor</i> |
| 2. <i>A. humilis</i> ♀ | x <i>A. manglesii</i> ♂ | | x self |
| | x <i>A. preissii</i> | | x <i>A. preissii</i> |
| | x <i>A. viridis</i> | | x <i>A. manglesii</i> (yellow) |
| | x <i>A. bicolor</i> | 4. <i>A. bicolor</i> ♀ | x <i>A. manglesii</i> (red) ♂ |
| | x <i>A. flavidus</i> (green) | | x <i>A. preissii</i> |
| | x <i>A. flavidus</i> (orange) | | x <i>A. humilis</i> |
| | x <i>A. flavidus</i> 'Pink Joey' | | x <i>A. viridis</i> |
| | | 5. <i>A. manglesii</i> (R) ♀ | x <i>A. flavidus</i> G ♂ |
| | | | x <i>A. bicolor</i> |
| | | | x <i>A. manglesii</i> (R) |
| | | | x <i>A. flavidus</i> (O/R) |

Seed was collected in late summer just prior to dehiscence, preheated for two hours in a waterbath at 55-60°C prior to sowing and sown in sand in deep pots and placed under mist. Seedlings were potted into a pasteurised mix of 1 peat : 2 sand with the following fertilizers:- 100 g Esmine1, 300 g Gu49, 1.5 kg Osmocote (8-9 month) (18-2.6-10), 3 kg Dolomite, 1.5 kg Lime per metre³ of mix, on 29 September, 1982. As the hybrids came into flower they were labelled with an identification number, e.g. 83-02-63 (year, month and identification number). It should be noted that *A. flavidus* did not play a major part in the pollinations because the flowering times of the other species did not coincide with it.

A large number of pollinations were carried out on plants of Hopper's hybrids; *A. manglesii* x *A. flavidus*, *A. preissii* x *A. flavidus* and *A. rufus* x *A. flavidus*. Backcrossing to the parent species and selfing was repeatedly attempted.

In November, 1983 a collection of *A. flavidus* colour variants and *A. humilis* plants was made (see colour plate, page 197) and hand pollinations were carried out in a glasshouse as the plants came into flower. Pollen was transferred using a camel hair brush and flowers were tagged as they were pollinated. Crosses with *A. flavidus* as either male and female parents were made. The flowers were not emasculated. Seed was collected in February, 1984.

Results and Discussion

Germination of the following hybrid seed was successful:		Number of Plants	Code Numbers
1. <i>A. humilis</i>	x <i>manglesii</i>	5	10, 11, 12, 15, 16
	x <i>viridis</i>	17	29-43, 48, 65
	x <i>bicolor</i>	4	44-46, 110
	x <i>flavidus</i> (Green)	26	1-8, 13, 25, 27, 53, 55, 59, 60-64, 66, 70, 72, 81, 84, 85
	x <i>flavidus</i> (Orange)	28	17-26, 49-51, 54, 56-58, 62, 67-71, 75-80, 83
2. <i>A. viridis</i>	x <i>bicolor</i>	1	47
	x <i>manglesii</i>	12	86-92, 105-109
3. <i>A. manglesii</i> R/G	x <i>manglesii</i> (Yellow)	13	86-92, 105-109

Hybrids made with *A. humilis* as a parent commenced flowering in February, 1983 and continued to flower freely for most of the year. Crosses involving *A. viridis* and *A. manglesii* as female parents flowered seasonally commencing in August/September, 1983.

Evaluation of these hybrids is in progress at the present time. The height of plants to the top of the inflorescence is in the range from 15 to 60 cm. A number of the hybrids are less than 40 cm in height. This height would be most suitable for flowering pot specimens. Hybrids of *A. humilis* x *bicolor* are generally in this range but flower size and colour are not spectacular.

A range of compact colourful, floriferous, hardy hybrids was produced by the crosses of *A. humilis* with colour forms of *A. flavidus*. The colour of *A. humilis* x *flavidus* (orange) flowers ranges from orange/red to apricot to pink/grey whilst *A. humilis* x *flavidus* (green) flowers are apricot, yellow/crimson, yellow/mauve and yellow/green. The *A. humilis* x *flavidus* hybrids appear to be very hardy in pot culture: there were no deaths throughout the first year and flowering was extended and unseasonal. Flower colour is variable especially in reddish varieties.

Crosses between *A. humilis* and *A. viridis* and *A. manglesii* were not of particularly good flowering form, colour or vigour. Crosses involving *A. bicolor* appear disease prone and unthrifty. Crosses between *A. viridis* and *A. manglesii* produced very tall flower stalks — to 1 metre — the flowers however were not outstanding and the foliage was poor. All hybrids appear to be sterile.

The selection procedure for superior hybrids is ongoing. Trials — both in the field and for pot culture in a range of environments and under commercial production conditions — are needed to gain a clear picture of disease susceptibility in order to avoid the same problems as were encountered with earlier hybrids.

The parental range of the hybrids produced here was quite narrow. More extensive breeding is being carried out by Mervyn Turner in Victoria and Keith Oliver in Western Australia to exploit fully the great potential of Kangaroo Paws.

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Banksia saxicola △

▽ *Banksia paludosa*



Eastern Banksia Of The *B. integrifolia* Group

by Tony Blake



Banksia marginata (above) — See page 206
Banksia saxicola (opposite, top) — see page 203
Banksia paludosa (opposite, bottom) — see page 207

Photography by Trevor Blake
Photography by Trevor Blake
Photography by Trevor Blake

Eastern *Banksia* of the *B. integrifolia* Group

by Trevor Blake

Banksias are worth growing in every garden for a number of reasons apart from the spectacular nature of their flowers. A range can be selected for screening, groundcover, and habitat creation. Many eastern species will succeed in gardens that have shallow clay soils or regular high humidity. Good nectar producers help to develop an extra quality in a garden by attracting honey-eating birds and insects which can change an ornamental display into a 'living system'. By establishing a healthy balanced garden ecology, the need to turn to chemicals to solve problems can be overcome. Banksias can assist in this respect.

It is exciting to consider that a genus as well known and obvious as banksias has been added to so recently as 1981 and it would appear that this discovery is far from over. Banksia forms differing from the species, sub-species and varieties so far described are still turning up in both eastern and western Australia which makes banksia atlassing even more worthwhile.

The eastern banksias, like other species, mainly inhabit the coastal strip extending into the southern slopes or summits of the Great Dividing Range. Several species prefer the moister, cooler areas of mountain ranges.

Habitats of some species are restricted and it is imperative that reserves be set aside to ensure the survival and diversity of this natural material. We cannot be just another horticultural group but must be dedicated to their preservation in natural areas in national parks and reserves. If we, as a group with expertise and interest in native plants can't press for their long term survival then we will lose credibility in the eyes of our members and the community.

The habit of growth of many of these banksias varies considerably and is genetic rather than caused by environmental conditions. *Banksia marginata* develops into a small tree in areas in the Victorian Grampians with low growing bushes being common around Melbourne's outer eastern suburbs. A vast range of intermediate habits occurs through its range. Recently a grey leaved form was collected along the Western Highway.

Hybridization occurs mainly within the eastern banksias and is more commonly found between *B. robur* and *B. oblongifolia*, but a number of other species have revealed this tendency. *B. ericifolia* with *B. spinulosa* var. *cunninghamii*; *B. marginata* with *B. conferta* var. *pencillata* and var. *conferta*, *B. compar* with *B. conferta* var. *conferta*, *B. saxicola* and *B. marginata* and *B. paludosa* with *B. integrifolia*.

***Banksia integrifolia* var. *integrifolia*. Linnaeus**

January-July

A well known species that has been cultivated for a long time, has proved adaptable to clays and sands in a range of climatic conditions but prefers sunny situations. See the photograph on page 189.

Growing to tree proportions of 20-25 m with massive trunks it is a species that has adapted well to coastal environments. The dark green, elliptical leaves can grow to 10 cm long and are arranged around the stems in whorls displaying silvery undersurfaces. The smaller cylindrical flowers are pale yellow and can reach 12 cm long. The fruiting cone sheds the old floral parts quickly and presents narrow follicles which open at maturity.

This species is naturally distributed from as far north as Fraser Island, Qld., down Australia's eastern seaboard to Port Phillip Bay, Victoria.

The species has two varieties.

***Banksia integrifolia* var. *compar*. Bailey.**

January-June

Has distinctive undulating foliage which can reach 20 cm long and is found in Queensland coastal areas and mountain woodlands of NSW.

This variety too, reaches tree proportions of 10-16 m depending on habitat. The flowers and cones are similar to var. *integrifolia* and the leaves too are arranged in whorls. Taller forms are found in forest situations and are more likely to be frost resistant than the coastal forms. It appears that this variety can recover from fire, shooting from epicormic shoots along the trunk.

Under cultivation the species appears to be tolerant of a range of soil types from heavier clays to sandy loams. It is able to grow well in filtered sunlight to full sun, but does require a rainfall of 800-1200 mm and can be grown successfully as far south as Melbourne.

With foliage longer and narrower than var. *integrifolia* it can be easily distinguished. Beautiful colour plate in Horticultural Guide 2/23.

***Banksia integrifolia* var. *aquilonia*. A. S. George.**

March-June

A northern variety which has slightly longer floral parts. The leaves grow from 5-20 cm long by 6-12 mm wide and differ by having rusty hairs along the under midrib. Unlike other forms of *B. integrifolia* the leaves are scattered along the stems and not whorled. It can reach tree proportions of 15 m high and sheds its seed at maturity. Under cultivation little is known of this variety but it is thought that it should do well in well-drained sandy soils in frost free areas. More data is required on its cultivation requirements.

The natural distribution of this form is in northern Queensland, extending north and south of Cairns from Mt. Finigan National Park to the Paluma Range.

***Banksia saxicola*. A. S. George**

January-March

Always referred to as the form of *B. integrifolia* from the Victorian Grampians, it has now been given species status.

Generally known as a tall bushy shrub growing in rocky situations on the higher peaks of the Grampians reaching 3-4 m high with a wider spread, it can, however, reach tree proportions of 13 m tall in forest situations, particularly from the only other known occurrence at Sealers Cove on Wilsons Promontory.

The leaves are whorled like *B. integrifolia* and similar, but the bark is thinner and therefore unable to withstand fire.

Perhaps the most distinguishing feature of this species is its retention of seed in closed follicles. See the photograph on page 200.

Under cultivation it is hardy to a wide range of soils and conditions including frost. Seed can be reliably germinated if placed in a refrigerator for about eight weeks to simulate winter conditions (stratification). Flowers are similar but a little greyish compared with the lemon yellow of *B. integrifolia*.



***Banksia oblongifolia*. Cavanilles (above)**

March-June

In the *Banksia* revision *B. asplenifolia* has been included under *B. oblongifolia*. It is a hardy shrub that can vary from a low spreading, bushy habit to a tall dense, open shrub of 3 m high. Frequently multistemmed from a lignotuber, it has the ability to regenerate well after damage or fire. The new growth is covered in dense, velvety, rusty-brown hairs which are shed at maturity.

Pale, yellow flowers are found along the branches in the axils of newer stem growth and are frequently tinged bluish when in bud. In colder areas multiple flowers are not uncommon. The cones shed the old floral parts as they mature.

This species is generally found in coastal areas of NSW and Queensland on the flat Wallum country where it is associated with *B. robur*. The soils are frequently sandy clays or clay-loams and can be quite moist at times. It also occurs in Queensland's Blackdown Tableland area.

Under cultivation it has proved a hardy adaptable species particularly in heavier soils where better drainage is required. It appears to be able to withstand frosts and can be planted in an open sunny situation or as an undershrub where it receives filtered sunlight. The above photograph is by Lois Sourry.

It appears to be a good coastal plant which can survive in semi-exposed areas where airborne salt spray and strong winds are experienced.

***Banksia conferta* var. *conferta*. A. S. George**

April-July

A large shrub of 3-4 m tall, and of dense habit which has a restricted distribution to the Glasshouse Mountains and Lamington Plateau in Queensland where it inhabits rocky, granite and sandstone slopes.

Horticulturally it is proving to be quite versatile to most soil conditions. The large pinkish-brown buds are generally found in branch axils and are partially hidden by the whorled leaves. At maturity the flower opens to gold.

The large leaves are similar to those of *B. integrifolia*, but have rusty hairs on the lower midrib.

It is known to flower three years after growth from seed and prefers well drained soils. It also appears to be able to withstand long periods of dryness and shows evidence of being able to withstand fire by developing a lignotuber and shooting from the trunk.

Distinguishing features are:

1. Persistent floral parts on spent flowers.
2. Crowded flower spikes.
3. Fruits persistent on the tree with closed follicles.
4. The older bark is thick and rough.

***Banksia conferta* var. *penicillata*. A. S. George**

March-June

Similar in habit to the previously mentioned variety, it has long cones crowded in the branch axils. The colour of both varieties is similar, but this variety does seem sensitive to fire as it produces thinner, smoother bark and no *lignotuber*. The most obvious identifying feature is the serrated leaf edge.

Found naturally growing on the sandstones of the Blue Mountains around Newnes Plateau.

Under cultivation this shrub is proving adaptable to a wide range of conditions. It is growing well and flowering in deep sands near Melbourne as well as shallow grey clays over deep yellow clay in full sun to dappled shade.

Distinguishing features are:

1. Smooth bark.
2. Serrated adult leaves.
3. Susceptibility to fire.

***Banksia plagiocarpa*. A. S. George**

January-June

This particular species was found on Mt. Bowen on Hinchinbrook Island, Queensland and the adjacent mainland. A large, spreading shrub of 5 m tall with a short thickened corky trunk that should withstand fire by sprouting epicormic shoots.

The narrow, scattered, lance-shaped leaves can reach 20 cm long and can be smooth-edged or slightly serrated.

The flower buds of this species are somewhat distinctive in being mauvish in colour, opening to pinkish-brown. The fruit too differs in that the triangular follicles are slightly upturned and the cone in its immature stage is a distinctive red-brown colour. The follicles do not open at maturity.

This species could be confused with *B. oblongifolia*, but differs in having:

1. Mauve coloured flower buds.
2. Triangular upturned follicles.
3. A single trunk.

At present it is hardly known in cultivation but seed has started to be distributed and seedlings germinated. Information is needed on this species.

***Banksia marginata*. Cavanilles**

February-July

Frequently called 'Silver Banksia' because of the thick white hairs coating the undersides of the leaves. This species is particularly variable in habit ranging from a stunted shrub 0.5 m tall to a specimen of tree status 12 m high. It can be found on exposed heathlands, in sandy loams or rocky soils ranging from sandstones, through limestone to granite and it grows well in clays. Some forms, generally taller, can be found in swampy soils. It is very widespread and common in south-eastern Australia, extending through the Bass Strait Islands to Tasmania where it is also widespread and common. Extending from the Eyre Peninsula in the west, it is found along the coastal side of the Divide to north of Sydney to Baradine and Guyra.

Some forms have adapted to fire by shooting from epicormic shoots or suckering. This latter condition can occur if the plant is physically damaged or the roots are disturbed. Other forms shoot from lignotubers whilst some are killed, shed their seeds and reproduce from seed.

Leaves can vary from 15 mm by 3 mm wide to 60 mm long with a width of 12 mm. The conical, pale yellow flowers can also vary from 5-10 cm by 4-6 cm wide and can be tinged grey just prior to opening. See photograph on page 201.

An obvious difference from *B. integrifolia* is that the leaves are scattered, not whorled. It can resemble *B. canei* closely but does not have pungent leaves and the follicles generally open as the fruit matures.

Hardy in cultivation in most soil types from clays to sands, rocky soils to limestones. It can be quite a fast growing species that prefers sunny sites to partial shade. Generally the shadier the position the more spindly. This species can withstand dry spells and frosts. A good nectar producer.

***Banksia canei*. J. H. Willis**

December-June

Aptly named the 'Mountain Banksia' because of its habitat. This species is found above 750 m in sub-alpine open woodland and heathland sites in north-eastern Victoria and adjoining Snowy Range country of NSW. It can be mistaken for *B. marginata* but differs by having larger follicles and styles. The leaves too, differ in that they end in a fine sharp point. The conical flower is pale yellow but in bud is generally tinged mauve. One form has a striking bluish appearance.

The soils this species prefers are generally moist clays or rocky types. Under cultivation it is slow and can prove difficult to keep going, however once established it develops into a dense bush. It can be grown in sunny or partially shaded areas and is able to withstand frost.

Similar to *B. saxicola* in many respects it is easily distinguished from this species in that it does not have whorled leaves. Similarly, it too requires seed to be stratified by placing in the refrigerator for 6-8 weeks prior to sowing.

***Banksia paludosa*. R. Brown**

April-July

This species is often referred to as the Swamp Banksia because of its habitat near water. It can be a compact or straggly shrub that can reach 1.5 m tall with a similar spread. Frequently low and spreading it has several stems from a lignotuber which indicates its adaptability to fire. Often found in moist heathland and woodland areas it requires good drainage. Dense clumps of this species are to be found in moist, sandy, acidic mountainous areas of the NSW coast. It is now believed to extend into Victoria. See photograph on page 200.

The entire or toothed leaves are arranged in whorls around the stems and the yellowish to golden brown flower heads are found on the previous season's growth at branch junctions.

Under cultivation it can be slower growing but is adaptable to a range of acidic soils from clays to sands. It can be grown in open, full sunlight or as an understorey shrub where it receives filtered sunlight. Tolerant of occasionally quite wet soils it prefers moist, but well-drained situations. It is however, able to withstand dry periods.

***Banksia robur*. Cavanilles**

Throughout the year

A Banksia of the coastal areas of NSW and Queensland. It is generally found growing around swamps, in wet heaths and in low woodland.

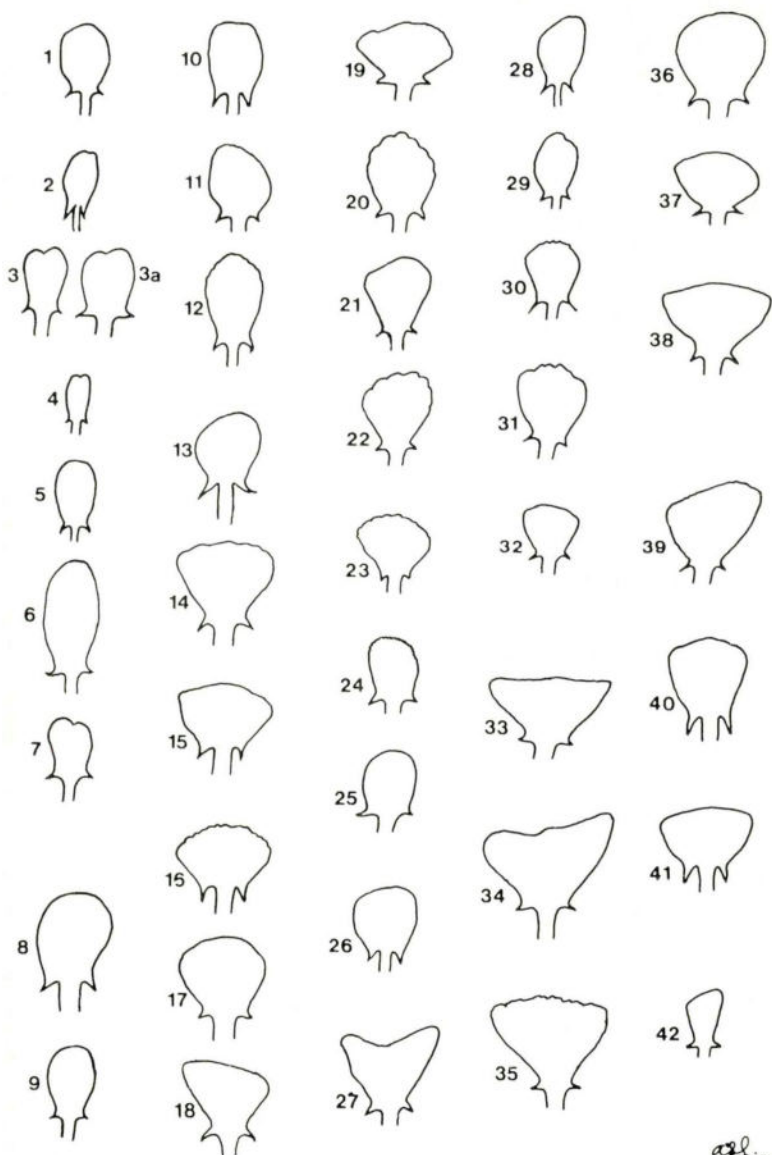
A multi-stemmed shrub that is frequently straggly and can occasionally reach 4 m. The large, broad, dark green leaves are covered with thick tomentum when young. Unmistakable bottle to metallic green flower buds are quite well displayed. As they mature they change through a range of greens to gold. Multiple flower heads occur in some forms.

Generally this species grows in wet peaty acidic sands in filtered sunlight; but can withstand dry spells and full sun. It will however do much better in moist conditions. It can be regarded as hardy in cultivation and will do quite well in clay soils. As a lignotuber is present the species survives fire and frost.

In Queensland it occurs as far north as Cooktown, Mareeba and Bowen but is more commonly known from southeast Queensland in Wallum country. In NSW it is found north of Wollongong to Kempsey. ■

***Banksia* — The Seedling Leaves**

by Alex George



as 16

It is possible to name many *Banksia* from the cotyledons, the first two seedling leaves. These sketches are reprinted, with permission, from 'Nuytsia' 3:3:1981, see opposite.

Banksia — The Genus

Book Review by The Editor

Our book "The Banksia Book" by A. S. George is the very best reference for the non-botanist. All species are described in simple terms with a line sketch to illustrate the features that distinguish one from another. There is also a large colour plate of every species, an excellent reference. This book is available from The Editor for \$29.95 plus \$2.05 postage.

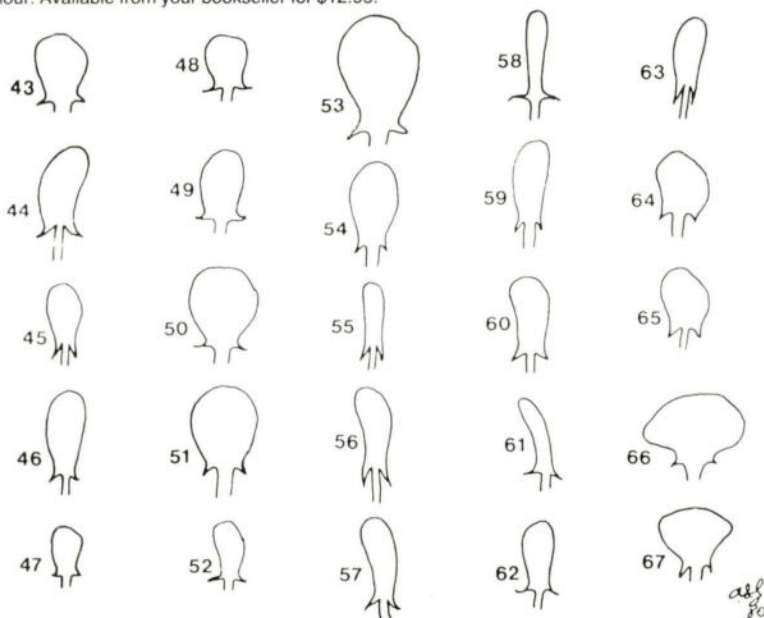
This book followed the publication of a review of the genus by the same author, at a scientific level, in the publication "Nuytsia", Volume 3, Number 3, 1981. "Nuytsia" is available from the W. A. Herbarium, The Department of Agriculture, Jarrah Road, South Perth 6151 for \$20.00.

This scientific work naturally includes many features not included in our book. One of these is the sketches shown here, of the cotyledons, the first two juvenile leaves, following germination. The sketches in "Nuytsia" are full size, as are photographs of the seed of most species. Many features of the originally published work make it attractive to those who can handle the scientific descriptions.

Australian Plants For Your Garden

by Glen and Peta Heyne

Another general book on the use of our wildflowers in the garden. The brief introductory section, 13 pages, advises on the application of plants to effect, and the remaining 150 pages, describes some 800 species more commonly grown with a guide to their specific use. The book is illustrated with some colour. Available from your bookseller for \$12.95.



Outlines of cotyledons of *Banksia* species. All are approximately natural size. 1—*B. dentata*. 2—*B. integrifolia* var. *integrifolia*. 3—*B. conferta* var. *penicillata*. 3A—*B. conferta* var. *conferta*. 4—*B. marginata*. 5—*B. oblongifolia*. 6—*B. robur*. 7—*B. paludosa*. 8—*B. grandis*. 9—*B. solandri*. 10—*B. quercifolia*. 11—*B. oreophila*. 12—*B. baueri*. 13—*B. serrata*. 14—*B. aemula*. 15—*B. ornata*. 16—*B. menziesii*. 17—*B. speciosa*. 18—*B. baxteri*. 19—*B. candolleana*. 20—*B. sceptrum*. 21—*B. prionotes*. 22—*B. victoriae*. 23—*B. burdettii*. 24—*B. media*. 25—*B. praemorsa*. 26—*B. pilostylis*. 27—*B. attenuata*. 28—*B. ashbyi*. 29—*B. benthamiana*. 30—*B. audax*. 31—*B. lullfitzii*. 32—*B. elderana*. 33—*B. goodii*. 34—*B. gardneri* var. *brevidentata*. 35—*B. chamaephyton*. 36—*B. repens*. 37—*B. blechnifolia*. 38—*B. petiolaris*. 39—*B. lehmanniana*. 40—*B. caleyi*. 41—*B. aculeata*. 42—*B. coccinea*. 43—*B. brownii*. 44—*B. dryandroides*. 45—*B. spinulosa* var. *spinulosa*. 46—*B. ericifolia* var. *macrantha*. 47—*B. occidentalis*. 48—*B. littoralis* var. *seminuda*. 49—*B. verticillata*. 50—*B. tricuspis*. 51—*B. sphaerocarpa* var. *sphaerocarpa*. 52—*B. sphaerocarpa* var. *caesia*. 53—*B. micrantha*. 54—*B. grossa*. 55—*B. leptophylla*. 56—*B. lanata*. 57—*B. scabrella*. 58—*B. telmatiaea*. 59—*B. laricina*. 60—*B. incana*. 61—*B. violacea*. 62—*B. meisneri* var. *ascendens*. 63—*B. pulchella*. 64—*B. nutans* var. *nutans*. 65—*B. nutans* var. *cernuella*. 66—*B. ilicifolia*. 67—*B. cuneata*.

PROPAGATION BY SEED GERMINATION

The seed of *Boronia serrulata* is borne in a capsule, which ripens between October and November ejecting the seed 1 or 2 metres from the plant. Collection of seed therefore necessitates harvesting capsules just before they ripen. These straw-coloured capsules are best collected in the early morning when they are still moist from dew. Collecting capsules is tedious because on any one day there may be fewer than four capsules per plant at this stage of maturity. Capsules are dried at room temperature in a covered box and seed will be ejected within 5 days. Careful attention must be given to the removal of cream-coloured insect larvae so as to prevent damage to seed. Such damage may only be evident with the aid of a hand lens.

Fully ripened seed is plump, black and shiny. If green capsules are collected and dried they will also open but the seed is dull, small and probably immature.

Both fresh and stored seed (15°C for 17 months) were subjected to various treatments including:-

- control (seed untreated)
- seed chipped at radicle end
- seed chipped and soaked in running water for two weeks
- seed chipped and soaked in water with a pH of 9 (to simulate soil pH after fire)
- seed immersed in boiling water and allowed to cool
- seed chipped and soaked in gibberellic acid (250 ppm)

Seed was sown in sterilized sand or sand:vermiculite (50:50) and maintained in a glasshouse at 24°C/19°C (day/night).

Germination was slow and erratic and the first seedling emerged 3 months after sowing the fresh seed and 5 weeks after sowing the stored seed. None of the treatments improved germination over the controls and seeds treated with boiling water failed to germinate. The best germination of fresh seed achieved after 7 months was 17%. Only 5% of the stored seed germinated. A viability test was performed on samples of fresh and stored seed using tetrazolium chloride (International Seed Testing Association 1967). The proportion of viable seed was 40% for fresh seed and 17% for stored seed.

Turner (1977), Armstrong (1978) and Whitehorne and McIntyre (1975) reported the difficulties in germinating seed of Australian members of the family Rutaceae including *Boronia* spp. McIntyre and Veitch (1972) showed that seed of *Eriostemon australasius* had a viability of 25%. Germination was improved by chipping the seed testa and by leaching the seed in water. Ten percent of seed germinated in response to these treatments, representing 40% of the estimated viable seed. When *Boronia serrulata* seed was subjected to the same pre-sowing treatments germination was not improved.

Humphrey (1972) reported that the treatment of seed of *Boronia megastigma* with boiling water did not improve germination. *B. serrulata* seed which was treated with boiling water failed to germinate.

The vigour of seedlings of *Boronia serrulata* was poor. The average time taken from the emergence of cotyledons from the testa to the appearance of the first true leaves was 8 weeks. Thirty nine seedlings were successfully grown in the shadehouse, 5 of which flowered in spring 1980, 20 months after sowing.

The collection of ripe seed of *Boronia serrulata* is difficult and the viability of the seed was low. It would appear therefore that seed raising would not be a practical means of propagating *B. serrulata* and that vegetative propagation might be a desirable alternative. Poor germination would present problems if a *Boronia* breeding programme involving *B. serrulata* were to be undertaken although *in vitro* culture of seeds may prove successful.

PROPAGATION FROM STEM CUTTINGS

Several experiments were conducted to investigate the effects of mother plant, rooting hormone (auxin), basal temperature and time of year of collection on the propagation success of *B. serrulata*.

Cuttings were either collected (under licence) from the Royal National Park near Sydney or from stock plants grown under shade. All cuttings were semi-hardwood shoots (80-100 mm length) and were initially cleaned in bleach solution (0.5% available chlorine) followed by plain water. When rooting hormones were used the base of cuttings were dipped for 5 seconds in an auxin solution in 50:50 ethanol:water. The propagation medium was pasteurized coarse sand and peat (3:1) and cuttings were placed in pots over electric heating cables and under intermittent mist.

In all experiments the source of cuttings had a significant effect on the success of rooting. The percentage strike among the different plants sampled in the Royal National Park varied between 5% and 100%. In one experiment when cuttings were selected in November the optimum treatment was achieved with applied auxin of 2000 mg L⁻¹ (50:50 NAA and IBA) and a basal temperature of 29°C. In other experiments excellent rooting was achieved without auxin.

The time of year of collection of cuttings was also found to be important with *Boronia serrulata*. The most favourable time for collecting cuttings was between November and March when the plant was generally in a vegetative state. Cuttings taken during late autumn and winter were very slow to root and success was low (c. 20%).

A problem encountered with *Boronia serrulata* is that rooted cuttings often go into dormancy after potting up. When new growth does eventually emerge it frequently displays symptoms of iron deficiency. Foliar feeding with a liquid fertilizer supplemented with iron chelate is often the only way to stimulate growth.

Selection of the best form (both terms of growth and flowering attributes and ease-of-rooting and establishment) is paramount in the propagation of *B. serrulata*. Applied auxin and bottom heat may assist in rooting but mother plant and time of year are probably more important.

PROPAGATION BY GRAFTING

Boronias are reported to be relatively short-lived garden plants although in their natural habitat their lifespan can exceed 30 years (Hewett 1975). Some of the reasons attributed to the often sudden death include root- and collar-rotting diseases and attack by nematodes (Hewett 1975), drying out of the shallow root system and high soil temperatures (Quick 1963). Cultivation around the root system of boronias has often been blamed for their death (Parry 1963). Presumably this causes root damage and facilitates the entry of fungal pathogens.

In contrast to *Boronia*, some other Australian members of Rutaceae are long-lived under cultivation (Elliot and Jones 1982). Were it possible to graft *Boronia* onto rootstocks of other Rutaceae, the longevity of *Boronia* under cultivation may be extended. The Dictionary of Gardening of 1885 reported the grafting of some species of *Boronia* onto *Correa alba*.

Attempts were made to graft *Boronia serrulata* onto other native and exotic members of Rutaceae using cleft, side, saddle approach, chip and cutting-grafts. The trials extended over a period of twelve months. Some of the rootstocks included *Correa* spp., Trifoliata rootstock (citrus) *Flindersia* spp.

Boronia serrulata formed compatible unions when grafted onto itself or onto other clones of *B. serrulata*. In all other grafts *B. serrulata* failed to callus and form a union with the rootstock. Sometimes the graft (especially cutting-grafts) survived for up to 2 months and made a little growth. However, when the grafting tape or parafilm was removed the scion either fell out or slowly withered.

The reasons for failure are not known but could include grafting technique or incompatibility. Generally I avoided grafting *Boronia serrulata* onto other species of *Boronia* since few boronias could be considered hardy and disease resistant. With the benefit of experience I now suggest that interested persons try *Boronia mollis*, *B. mollis* x *fraseri* or *B. clavata* as rootstocks for *B. serrulata*. ■

The Native Rose

Growing *Boronia serrulata* by Allan Black, Toronto, NSW.

As a boy the native rose was my favourite, as it is today.

Well over 60 years ago, we used to cross over an elevated bridge in an area then known as Spring Valley, adjacent to the Water Board's septic tanks at East Hornsby, to seek out the native rose. This native gem was usually found under the shade of a huge rock.

My initial impression was of the fragrance and lovely rose pink colour of the flowers, the compactness of the foliage and the gentle swaying of the stem reminiscent of a ballet artist.

Some thirty years later I resolved to grow my own plants.

First try: I prepared a small plot, which I filled with a medium of poor grey sand. The aspect was North with morning sun and protected from all winds. A couple of purchased plants were placed in this medium, and after a short time it was obvious that their early demise was imminent. A post-mortem revealed that no moisture had penetrated the roots, the sand being too fine and so lacking drainage, with the result that the hot sand had burned the roots.

Second try: Having discarded that disappointing method, I obtained two plastic buckets and with gravel at the base filled them with 50% river sand, and 50% poor grey sand with some peat moss. Two more native rose plants were purchased and placed in the buckets, which were then stood on timber shelves under 70% Sarlon shade cloth in a protected situation, but these too, succumbed to either lack of drainage or too much water.

Third try: I propagated my own plants. Despite many failures in the past, as the experts claim that this species is easy to strike I tried a new approach. I built a bush house with elevated planks, and placed on them four 100 mm pots containing native rose cuttings. The pots were covered with clear plastic bags with a medium of very coarse sand (very fine gravel) some perlite, and sieved German peat moss. The pots were surrounded by wet peat moss, set in ice-cream containers and placed on shelves in the bush house. With a cool environment, and filtered sunlight, the plastic bags provided condensation for moisture. It was not necessary to remove them for water for nine months. A number of cuttings had struck in each pot.

Fourth try: In view of my passion for native rose I devoted many hours of thought to determine successful techniques for cultivating them. I gave birth to a new concept. My experiment was based on the established theory that this species enjoys a cool root run. I obtained what is known in the trade as an earthenware sinkstone, more commonly recognised by the householder as a gully over which a tap is placed, and which forms a part of the sewerage system. It is about 40 cm square with four sloping sides to 100 mm outlet.

I prepared a raised bed using corrugated iron sides, 75 cm × 47 cm wide with a sloping floor draining away to a 50 mm pipe. It was 34 cm deep at one end and 140 cm at the drainage outlet. A layer of 70 mm size stones provided a rubble drain on the bottom. To this was added 15 mm size gravel to a level of 34 cm from the top of the box. This allowed me to place the earthenware sinkstone at the shallow end of the bed, the drainage hole resting on the gravel, the top edge being level with the top of the box. The whole, including the sinkstone was then topped up with a commercial potting mix to which was added 5% German peat moss.

I purchased a native rose plant 25 cm high and flowering nicely and this I planted in the sinkstone. Ten months later there were about 27 stems developing like a mushroom effect, rather than vertical, some attaining a height of 61 cm. A few are in full flower, but mostly in bud. A second plant 21 cm high and not flowering was also purchased and placed in the opposite end of the plot. Eight months later it is about 37 cm high and growing vertically and flowering well. A well established plant of my own was planted between the other two and also flowered well. It will be noted that the last two plants were not placed in the sinkstone proper but in close proximity using the same medium.

For a fertilizer I applied Osmocote pellets about every six months. The plants are mulched with coarse pine bark and watered lightly on alternate nights.

The bed was constructed outdoors to receive the morning summer sun to 10.00 a.m. It is then covered with a piece of movable 70% Sarlon shadecloth, placed at an angle 1.3 m above the bed. When the hot sun moves off the plants at 2.00 p.m. the Sarlon is removed till 10.00 a.m. next day. This Sarlon is not used on dull days or in winter. This winter treatment resulted in their foliage turning a bronze colour, reverting to the normal green in spring when the Sarlon is again used.

Why all this trouble? I was determined to test my theories. Drainage is important but more especially a moist draining slab produced good results. I feel that when the roots of the *Boronia* make contact with the sloping sides of the stone-ware, there is a cooling effect. The plant in the sinkstone is very much superior to the two outside it growing in the same well-drained medium.

I now have huge sprays of my favourite, the native rose. ■

Flora Of Australia

This is the title of a series of books produced by the Commonwealth Government of Australia, presenting as volumes, descriptions of the entire Australian flora. The latest, Volume 22, describes the plants grouped by botanical scientists in the Rhizophorales to Celastrales. This probably means as little to most of readers of Australian Plants as it does to me, the Editor. Likewise, the book is written for scientists and students being essentially a scientific reference text. Or has it wider appeal?

That section dealing with the genus *Macgregoria* and its only species, *Macgregoria racemigera*, is reproduced in part opposite with the description below. Not all species are so well illustrated but this sketch is reproduced with permission, the caption including the description given in the text. "Heavy stuff" for most but many of us are buying a copy of each volume as it is produced as it is such a valuable reference to our flora.

Volumes so far produced and available by mail from The Editor, Australian Plants are:

Volume 1, \$10.00 (\$1.50 postage) — Vol. 4, \$23.00 (\$2.00 postage) — Vol. 8, \$25.50 (\$2.00 postage) — Vol. 22, \$19.00 (\$2.00 postage) — Vol. 29, \$19.00 (\$2.00 postage).

Macgregoria racemigera

An erect to procumbent glabrous annual to 15 cm high. Leaves narrowly linear, 5-15 mm long. Inflorescence a raceme; flowers white with pink throat, arranged singly, subtended by bract at base of slender pedicel 3-8 mm long. Hypanthium much shorter than narrowly triangular sepals, together 1.5-2.5 mm long. Petals narrowly spatulate, 5-10 mm long. Cocci obovoid, 0.7-0.8 mm long, densely papillose, covered by hooked hairs. See sketch opposite.

Occurs widely across arid Australia but not recorded from northern S.A.; grows in sand or clay or sometimes gravelly soil, on ridges and plains, sometimes in depressions, in hummock grassland and woodland.

Research Project

Fungal Plant Diseases on Natives In Victoria

One of the many research projects supported by The Australian Flora Foundation is "A taxonomic survey of pathogenic fungi associated with Victorian native plants of economic importance to ornamental horticulture". The research is being carried out by Ian Pascoe, Mycologist, Burnley Plant Research Institute of the Department of Agriculture, Victoria, Burnley Gardens, Swan Street, Burnley, Victoria 3121. He is working with Dr. B. C. Sutton of the Commonwealth Mycological Institute, Kew, England surveying fungal plant diseases from natural habitats and nurseries throughout Victoria.

Ian Pascoe is anxious to hear from any SGAP members including commercial nurserymen, who would be interested in becoming involved in aspects of this project. I am not sure what this involves but if you have noted a fungal problem, please contact him as above.

Chamelaucium

The Geraldton Wax, etc.

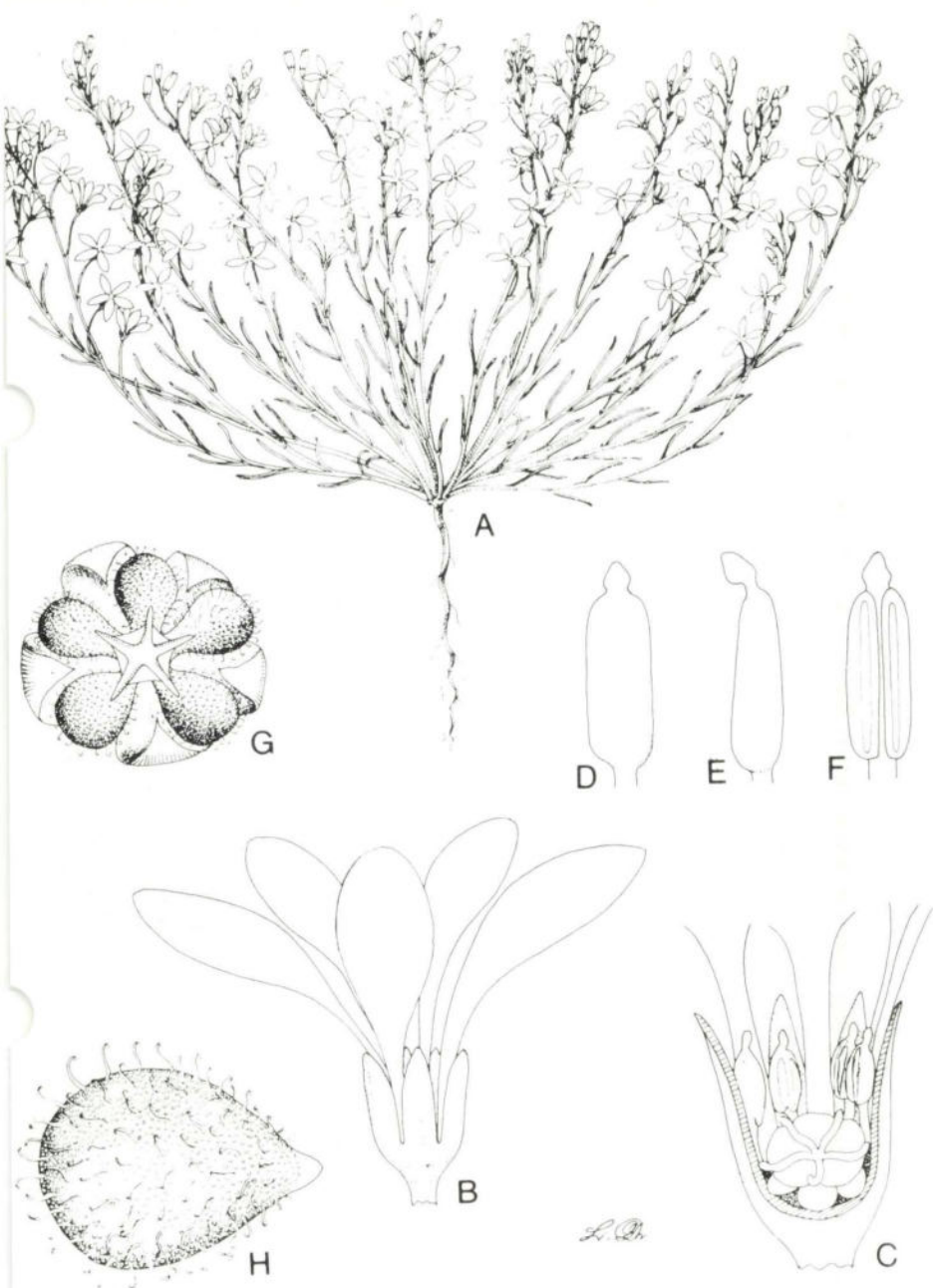
A research project involving selection/breeding with *Chamelaucium* species for plants suited to cut-flower production or as flowering potted plants needs urgent help. Plants or fresh cuttings of the following species are needed: *Chamelaucium drummondii*, *C. confertifolia*, *C. arenicolum*, *C. juniperinum*, *C. pauciflorum*, *C. vinosum* (oenanthem), *C. virgatum*, *C. naviculatum* and *C. leptocaulum*. If you can help please contact Greg Lamont, Horticultural Research Station, P.O. Box 720, Gosford, NSW 2250.

Lechenaultia

Who would be interested in a study group on these fascinating colourful plants. Denis Margan, C/- P.O. Box 61, Toongabbie 2146, wants help to grow all the colour forms as potted plants and already has a large collection. The subject is so rewarding and requires so little space there must be many readers keen to join in this rewarding study. Initial enquiries should be directed to Denis.

The Pea-flowered Plants

The range of our wildflowers with the characteristic flower shape of pea-flowers is most impressive. So too is the way these well-flowered plants display their flowers and present themselves when not in flower. To Kelvin Perks, 2 Barton Street, Concord, NSW 2137, they carry a fascination all their own. He would be keen to hear from any reader who will collect or exchange seed for him and would like to join a study group in these plants. There is a lot of interesting rewarding work to be done. No prior knowledge of botany, horticulture or indeed, of wildflowers is necessary.



Macgregoria racemigera; A, flowering plant x0.5; B, a flower x7; C, the lower part of the flower with one side removed x10; D-F, the anthers x11; G, a fruit x0; H, the coccus x30.

MICROÖRGANISMS IN THE SOIL — 2

by John Ferguson — Edited*

The complete breakdown of organic matter by microbes requires numerous steps and many types of organisms. Soil organisms differ greatly in their ability to attack a given substrate. When an organic material is added to the soil it is immediately available for some species, but completely unavailable to others. The soil population shifts, a succession of different forms predominating as the food materials are decomposed and their chemical constitution changed. Thus, organic-matter breakdown supports a sequence of organisms, each efficient in utilizing specific degradation products. Because of this great diversity of organisms a soil population can digest nearly any material supplied to it. When microörganisms decompose a substrate, many of the essential elements are used to form the material of their developing cells. These materials are thus rendered unavailable to the plant until the organisms die and are decomposed by other microörganisms.

Rate of decomposition

As an example of the rapidity of transformations by organisms, in a few hours sugar can be completely decomposed to carbon dioxide and water, or protein to ammonium, carbon dioxide, water, and other compounds. The extent to which microörganisms develop is limited by the nutrient substrate, environmental conditions, and the formation of certain products injurious to their activities. Although modifications in the supply of oxygen, moisture and inorganic compounds, or a change in temperature may affect the development of the soil population, the greatest response in activity is accomplished by the addition of organic substances to the soil or by treatments which destroy part of the soil population. One research study showed that when a tonne (dry weight) of fresh organic matter, such as manures or plant stubble, is worked into soil the microörganisms immediately become active. First, the water-soluble substances are decomposed, then the starches, the proteins, and cellulose. Within 10 to 20 days, under favourable conditions, only about 1,000 to 1,200 pounds may be left out of the 2,000 pounds originally added. Our experience with hoof and horn meal, peat, or wood shavings indicates a much slower breakdown with these materials. This is one of the reasons why leaf mould and manure are not used in the U.C. type mix.

Carbon/nitrogen ratio

Much can be interpreted regarding end products which will be formed and the speed of their formation if the organisms effecting the decomposition of an organic material, the composition of the material, and the environment are known. Fungi use the organic nutrients as a source of energy and of carbon. They use for synthesis of their cells an average of 40 percent (a range of from 10 to 65

*Microörganisms In The Soil — Edited

This article by John Ferguson is reproduced, by permission, from "The U.C. System for Producing Healthy Container-Grown Plants", edited by Kenneth F. Baker, Manual 23 of the California Agricultural Experimental Station of the Division of Agricultural Sciences, University of California, Los Angeles, USA. It has been edited only slightly for Australian conditions by the Editor, Australian Plants, with sincere apologies for any errors or unintended change of emphasis.

This is a series selected to give us a better understanding of below ground conditions, Editor.

percent reported by most workers) of the carbon contained in the organic compound decomposed. The remainder of the carbon goes off as carbon dioxide or is left as incompletely decomposed material. Bacteria and actinomycetes (in the presence of normal amounts of oxygen) assimilate an average of 25 percent of the carbon contained in the decomposed organic material.

Accompanying the carbon assimilation, appreciable amounts of nitrogen are used in the formation of cell proteins.

Effect of adding low-nitrogen materials

The following examples indicate the reactions observed when certain materials are added to soil.

When 100 kg of wood shavings containing 35 percent carbon and 0.2 percent nitrogen are added to soil, complete decomposition by *fungi*, on the basis of 40 percent assimilated by fungi, means 14 kg of carbon is assimilated. This results in 1.4 kg of nitrogen being assimilated also. (The carbon content of microbial cells averages about 50 percent of the dry weight. The nitrogen content is about 5%, a ratio of 10:1).

The amount of nitrogen furnished by the shavings was only 0.2 kg but that used by the fungi was 1.4 kg; therefore 1.2 kg of nitrogen would have to be supplied to the fungi for the decomposition.

This shows that the soil microorganisms would be competing with the plant for the available nitrogen in the soil. *In most cases the microorganisms are more successful than crop plants in obtaining the nitrogen needed.*

This process explains the temporary nitrogen deficiency noted in plants after the applications of wood shavings and other materials low in nitrogen.

Assimilation of nitrogen by microorganisms does not mean that nitrogen is permanently tied up in microbial cells. Microorganisms are relatively short-lived (for example, bacterial cells may live only 2 days, those of fungi several weeks), and upon their death and decomposition by other organisms the nitrogen and other elements which were assimilated are partially released.

The temporary nitrogen deficiency caused by additions of low-nitrogen materials can be overcome by the addition of inorganic nitrogen fertilizers or by composting the organic materials with nitrogen before planting. Composting enables the material to be decomposed and to reach a relatively stable state before its use. Composted material does not support the rapid growth of organisms resulting in nitrogen competition. There are, however, numerous disadvantages in its use that will be discussed in a future issue.

A very striking example of rapid microbial use of nitrogen occurs with the addition of sugar to soil. Sugar has a high carbon percentage, no nitrogen and is water-soluble. A small amount added to soil high in available nitrogen will so enhance microbial development as to completely tie up the nitrogen in less than 2 days. This phenomenon has been used in the laboratory to reduce the soluble nitrogen in pots of experimental plants, with rapid and complete results. Some growers have used it to prevent soft growth of their plants in recently fertilized soil when confronted with an unexpected cloudy period.

Most reports agree that *with organic materials containing less than 1.5 to 2 percent nitrogen a deficiency usually results upon decomposition.*

Effect of adding materials with over 2 percent nitrogen

Materials containing over 2 percent nitrogen supply more than is required by the microorganisms. This excess appears as ammonium (later oxidized by bacteria to nitrate under many conditions).

An example of a material with more than 2 percent nitrogen is dried blood meal with 13 percent nitrogen. If completely decomposed by fungi, the following calculations would apply:

100 kg of dried blood containing 40 percent carbon = 40 kg of carbon
it contains 13 percent nitrogen = 13 kg of nitrogen
40 kg of carbon, 40 percent assimilated by fungi = 16 kg of carbon assimilated
Ratio of carbon to nitrogen for fungi = 10 to 1 = 1.6 kg of nitrogen assimilated
Nitrogen available for crop, 11.4 kg.

The excess nitrogen would appear as ammonium as the decomposition progressed. The ammonium, a waste product in the nutrition of the fungi, then would be available to higher plants. This shows why there is plant stimulation when organic matter with more than 2 percent nitrogen is added to soil.

Similar calculations could be made to illustrate the results of the same decompositions by bacteria with a carbon to nitrogen ratio of 5:1, or actinomycetes with a ratio of 6:1. Bacteria and actinomycetes assimilate less carbon than fungi, but have higher nitrogen requirements.

The cells of microorganisms contain more than 2 percent nitrogen and when they die and are decomposed by other organisms, nitrogen becomes available.

Effect of Environmental Factors — Temperature

Since the availability of elements from organic materials depends upon their liberation by the activities of organisms, any factor affecting the growth of soil organisms will also affect the availability of such plant nutrients. The effect of temperature exemplifies this principle. At optimum temperatures for soil organisms, organic matter is broken down most efficiently. The process, mentioned earlier, of using sugar on soil to reduce available nitrogen proceeds most rapidly at the optimum temperatures for the organisms involved. Many growers have noted how much longer it takes organic nitrogen to become available in winter than in summer. Soil may also be stored longer at lower temperatures before the decomposition of organic materials releases a toxic concentration of nitrogen. The nitrogen cycle will be described in a future issue.

Effect of Available Oxygen Supply

The formation of peat, an important constituent of the U.C.-type mixes, illustrates the effect of a lack of gaseous oxygen on decomposition by organisms. The saturation with water of the material in peat bogs, and the resulting exclusion of air, prevents the complete oxidation of the organic matter. Aerobic fungi and bacteria cannot function under these conditions, and the decomposition of organic matter is dependent largely upon the activities of anaerobic bacteria. These organisms can function without oxygen from the air, but can decompose only slight amounts of such organic constituents as waxes and lignin, while other constituents are broken down very slowly. Peat is formed as the result of the accumulation of resistant plant residues over a long period of time in an air-free habitat. Once formed, it resists decomposition, even when exposed to air. Hence, although it contains only about 1 percent nitrogen, it does not cause a nitrogen deficiency. This is one reason why it is a very important constituent in the U.C.-type mixes. Hardwood sawdust and shavings are better for use in U.C.-type mixes than are those from pine and fir, for the same reason.

These examples illustrate the importance of soil organisms and the processes they perform. By understanding that **any factor affecting growth of microorganisms affects plant growth**, much mystery in growing plants is explained. ■

Terrestrial Orchids

Their Culture

by L. T. and M. K. Nesbitt



Australian deciduous terrestrial orchids are adapted to a mediterranean climate such as occurs in the southern states of Australia and in these areas are easy to grow. In Adelaide, they thrive in a shadehouse of 50% shadecloth. New South Wales and Queensland growers may need to provide some overhead protection from rain in warm weather. Victorian growers often provide overhead protection from winter rain and water by hand. In very cold areas an unheated glasshouse may be required for frost protection, although light frosts do not worry the majority of species.

Australian ground orchids normally follow an annual growth cycle comprising 6-8 months as growing plants under cool (5-15°C) moist conditions and 4-6 months as dormant tubers in hot (15-40°C) dry conditions. All species like good air circulation and will not thrive in a stuffy humid atmosphere especially if temperatures are high. Some species prefer heavy shade, others full sunlight, but most will adapt to a wide range of light intensity. If the leaves and stems are weak and limp or if the leaf rosettes are drawn up to the light then shading is too dense and the amount of light should be increased. The spring flowering species can take higher light intensities at flowering time as flowers may not open properly under dull conditions.

Keep the soil moist at all times during active growth by watering gently if there is no rain. Handwatering is especially necessary in spring as soil in pots dries out more rapidly than that in the garden. Watering must be done slowly so that the mat of needles on the surface of the pot is not disturbed. Slugs and snails love these plants and must be kept under control.

Be very careful with fertilisers because some terrestrial orchids are easily burnt or even killed by overuse. *Pterostylis*, *Chiloglottis*, and *Diuris* are very hardy and will benefit from weak applications of folia feed in the early growth stages. Do not use fertilisers or insecticides on the more difficult to grow *Caladenia* and *Thelymitra* species. These species depend on a delicate association with certain fungi in the soil, an association which is easily upset by chemical treatments.

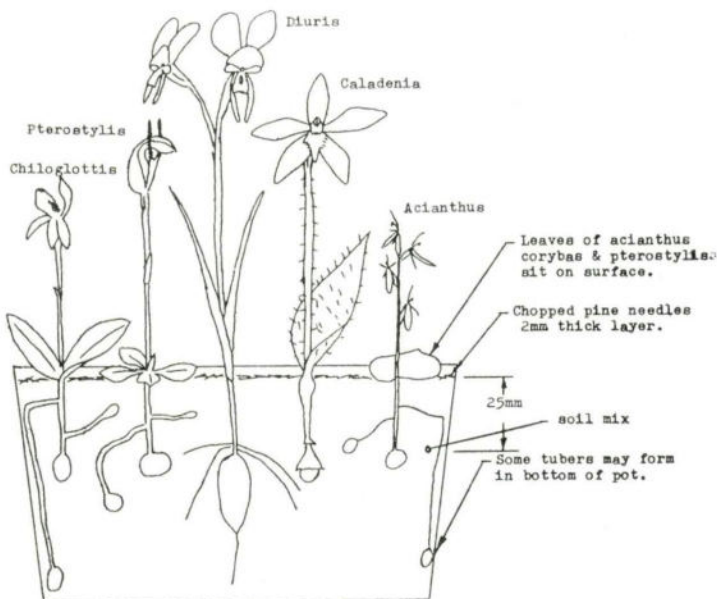
The new tubers are produced in winter-spring. Most of the species on the following list are colony types, that is, they multiply each year by forming several tubers per plant. Some time in spring the green leaves go yellow and then brown and dry as the days get hotter and drier in late spring. After the leaves have turned brown, let the pot dry out completely to dry up old roots and tubers otherwise they will turn into a soggy mouldy mess and infect the adjacent new tubers.

The pots can be knocked out and the tubers examined in summer without harm. We find that the best results are obtained if the tubers are repotted in fresh soil each year. Our soil mix is 40% loam, 45% sand, and 15% peatmoss with a little blood and bone fertiliser added. In other states a coarser mix with hardwood chips or leaf litter in place of the peatmoss may give better results. Replant the dormant tubers with the tops 20 mm deep. Cover the soil surface with a mulch of pine or sheoak needles, chopped to 20-50 mm long, to prevent erosion. Repotting is normally done in November, December and January.

Keep the pots shaded and allow the pots to dry out between the light waterings until the end of February when they may be set out in their growing positions and watered a little more often. The tubers of some species will rot if kept wet during the dormant period, others will produce plants prematurely which are then attacked by pests such as thrip and red spider, and fungal diseases in the warm weather. Each tuber sends up a shoot to the surface in autumn and leaves grow rapidly in late autumn-early winter as the rains set in. *Pterostylis* are usually the first to appear in March, followed by *Diuris* in April, *Caladenia* in May and *Corybas* in June-July.

Plants may be obtained in summer as dormant tubers. In late autumn-early winter plants are usually obtained with bare roots packed in sphagnum moss packing. Remove this carefully and pot up immediately into 180 mm squat plastic pots (3 or more plants) or 150 mm standard plastic pots. Half fill the pot with soil mix. Hold plant so that the final soil level will be at the same point on the stem as before shipment. Fill in around roots with more soil and gently firm the soil around the plant. Cover soil with chopped pine needles. Water gently, but thoroughly to settle the soil. Lift leaves onto top of pine needles. Place pots in shaded growing area. Good air circulation over the pot is essential to prevent mould and leaf rot. Sun loving species (*Thelymitra*, *Diuris*, *Microtis*) prefer a brighter location for good growth. *Corybas* like the shadiest corner.

Australian deciduous terrestrial orchids are delightful plants to cultivate. ■



The Terrestrial Orchids, *Chiloglottis* (opposite)

Drawings by Colin Woolcock

A — *Chiloglottis reflexa*; B — *Chiloglottis cornuta*; C — *Chiloglottis gunnii*; D — *Chiloglottis trapeziformis*. Commonly known as Bird Orchids, there are seven species found in Australia. Reproduced from **Australian Terrestrial Orchids** by C. and D. Woolcock, published by Thomas Nelson Australia at \$40.00. This book is available from The Editor, Australian Plants for \$38.00, post free, for orders received before April, 1986.



A = *Chiloglottis* — B = *Chiloglottis cornuta* — C = *Chiloglottis gunnii* — D = *C. trapeziformis*.

Some Terrestrial Orchids Recommended for Cultivation

Acianthus exsertus (Mosquito Orchid). A small red-brown multiflowering orchid. It prefers a moist shady position. Blooms, May-June.

Caladenia latifolia (Pink Fairies). Grows easily and multiplies quickly. It has a large hairy leaf and 1-3 pretty pink blooms on a hairy stem in August-September.

Caladenia menziesii (Hare Orchid). Grows and multiplies well but is hard to flower. It likes a moist shady spot. Dainty red and white blooms in September.

Chiloglottis formicifera (Ant Orchid). A dwarf plant with two broad leaves and a single reddish-brown flower in June-August. The flower stem elongates after fertilisation. It is a shadelover. See colour plate on page 221.

Chiloglottis reflexa (Autumn Bird Orchid). A plant similar to *C. formicifera*. The flower is pink, green and brown. March-July.

Chiloglottis trapeziformis (Broadlip Bird Orchid). A plant similar to *C. formicifera* but the leaves are a darker green. The flower has a much larger labellum. Blooms, August-October.

Diuris brevifolia (Short Leaf Diuris). Has 3-5 long lasting yellow flowers with brown markings in October-November. They have tadpole shaped tubers.

Diuris laxiflora (Bee Orchid). Has 3-5 smallish yellow flowers with distinctive brown markings. August-September. The cluster of thin leaves is distinctive.

Diuris longifolia — South Australian form (Wallflower or Donkey Orchid). Bears 2-4 large attractive brown flowers on a tall stem in September. It prefers light shade and multiplies well.

Diuris longifolia — Western Australian form — A larger, more richly coloured clone than South Australian types. The tubers are longer and thinner. Flowers in September-October.

Diuris maculata (Leopard Orchid). Has 3-9 cream blooms, heavily spotted with brown in August-September. It is easily grown and is a reliable flowerer.

Diuris sulphurea (Spotted Donkey Orchid). Has a tall spike bearing 3-5 yellow flowers with large brown spots in September-October. These are long lasting flowers.

Microtis parviflora (Sweet Onion Orchid). Is less robust than *M. unifolia*. It has 20-50 tiny green flowers in late spring.

Microtis unifolia (Common Onion Orchid). Has a tall stem with many tiny green flowers in late spring. The single leaf is hollow like an onion leaf and the flower spike grows through a split in the side of the leaf.

Pterostylis alata (Striped Greenhood). Is a slender plant bearing a green and white flower with reddish stripes in April-August. It is in the Cauline group, which means that flowering plants have stem leaves and non-flowering plants have a rosette of leaves flat on the ground.

Pterostylis angusta multiplies into colonies and is also of the Cauline group. It has a smallish flower which appears to have been squeezed at the top with dark red-brown stripes on a white base. May-June.

Pterostylis baptistii (King Greenhood). The North Queensland form has a single large green and white bloom anytime in autumn-winter-spring. It has a short dormancy.

Pterostylis baptistii 'Janney'. The New South Wales form has very large shapely flowers in spring.

- Pterostylis* sp. af. *baptistii*. This Queensland species appears to be midway between *P. baptistii* and *P. curta*. The green and white flower appears in late winter.
- Pterostylis coccinea* (The Red Hood). Is a colony type of the cauline group. It has a handsome, large red striped flower in March-May. Keep the pots cool and lightly watered in summer or it will not flower.
- Pterostylis concinna* (Trim Greenhood). Is a dwarf plant with a single small green bloom marked with red-brown. It is prolific, free flowering and hardy. June-August.
- Pterostylis curta* (Blunt Greenhood). Has a large green and brown flower in spring with a twisted labellum. It is hardy and multiplies rapidly.
- Pterostylis* sp. af. *decurva*. This unnamed species from Queensland has a small green and white flower in July-September. It is also of the cauline group.
- Pterostylis fischii* (Stately Greenhood). Is a tall slender flowering plant bearing 1 or 2 stately green and brown blooms in April-June. Cauline group.
- Pterostylis grandiflora* (Superb Greenhood). Also of the cauline group, the attractive green and brown flower appears in April-August.
- Pterostylis nana* (Dwarf Greenhood). A small green and white bloom appears in mid winter on these small plants. They multiply well.
- Pterostylis nutans* (Nodding Greenhood). Is a robust grower. It likes a shady spot and multiplies rapidly. The green nodding flowers are in winter-spring.
- Pterostylis obtusa* (Blunt Tongue Greenhood). Has a green and white striped flower. Stem leaves are on flowering plants in May-July. They are easy to grow.
- Pterostylis ophioglossa* (Snake Tongue Orchid). This greenhood has a forked tongue; the flower is brown, green and white, April-July.
- Pterostylis ophioglossa* subsp. *fusca*. The flower is dark reddish brown. June-August.
- Pterostylis pedoglossa* (Prawn Greenhood). Is a dainty plant with a green and white flower. The three sepals have long feeler-like extensions. Flowers are in April-July.
- Pterostylis pedunculata* (Maroonhood). Is spring flowering, the small brown bloom being on a tall stem. It is a hardy shadelover and multiplies prolifically.
- Pterostylis reflexa* (Small Autumn Greenhood). Has a single green flower with red-brown markings on a long stem in April-June. The long labellum protrudes from the flower. It is a cauline type.
- Pterostylis revoluta* (Autumn Greenhood). Has a large green and white flower in Autumn. Also of the cauline group, it prefers a bright well-drained location. It flowers in March-June if the tubers are kept cool in summer.
- Pterostylis rogersii* from Western Australia is very attractive having a white flower with broad red stripes. May-June. Also of the cauline group, it multiplies readily.
- Pterostylis scabra* var *robusta* (Sharp Leaf Greenhood). Has a large green and white striped flower in mid winter. It is in the cauline group. It prefers a well drained spot.
- Pterostylis truncata* (Little Dumpy Greenhood). Is a dwarf plant with a large red, green and white striped flower on a short stem in April-May. It is in the cauline group.
- Thelymitra antennifera* (Rabbit Ears). Bears 1-3 large scented yellow flowers which open freely on warm days in spring. It has brown 'ears' on top of the column. It multiplies.
- Thelymitra nuda* (Scented Sun Orchid). Carries 4-6 mauve flowers which open freely on warm days in October-November. A sunlover, it multiplies slowly.

Grow What Tree

by Australian Plant Study Group

This is the fifth book in the "Grow What Where" series and is designed to guide the beginner, the home gardener who wants to plant a few trees but is unsure which ones will grow, not be a menace and will add character or shade or shelter to his home/living area. A sub-title to the book is "250 Australia Native Trees for your Garden or Farm and How to Grow Them".

The introductory section is on the application and planting of trees followed by descriptions and sketches for every tree selected. These are followed by 34 lists, the trees described being grouped in relation to their application as follows:

Tree Types	Conditions Tolerated	Uses
1 Tall skinnies	12 Under large pines and eucalypts	24 Firewood
2 Courtyard	13 Ground wet in winter, drying out in summer	25 Fodder
3 Tubs	14 Tolerating some wetness	26 Koala food
4 Deciduous	15 Permanently boggy soil	27 Honey trees
5 Long flowering	16 Ponds	28 Edible fruit
6 To blend with exotics	17 Exposed coastal conditions	29 Trees for schools
7 Fire retarders	18 Salt soils	30 Nature strips
8 Soil binders	19 Tolerating moderate lime	31 Trees providing light shade
9 Sand binders	20 Tolerating heavy lime	32 Trees providing heavy shade
10 Suckering	21 Snow tolerant	33 Trees providing fern protection
11 Erosion control	22 Smog tolerant	34 Trunks suitable for epiphytic ferns and orchids
Precautions		
35 Branch droppers		
36 Drain cloggers		
37 Frost tender		

There are many beautiful colour plates. I have chosen to reproduce that of *Leptospermum phyllicoides* opposite for a special reason. The description in the book and the supporting sketches is as follows:

Leptospermum phyllicoides

phyllicoides: from the genus *Phylla*; *G aides*, like (small, narrow leaves).

SIZE: 2.5-4 m x 2-4 m.

HABIT: Weeping.

FOLIAGE: Dense, small leaves.

FLOWERS: Massed, fluffy, white flowers in spring and summer.

CULTIVATION: Sandy or clay soils. Withstands wetness, moist shade, permanently boggy conditions, and areas wet in winter and dry in summer. Frost resistant, and snow tolerant.

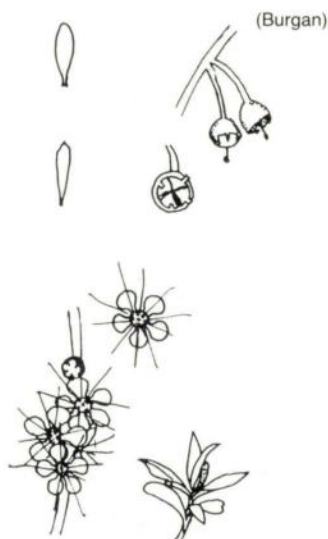
COMMENTS: Upright trunk, with weeping branches, beautiful in flower.

USES: Fence screener, hedge, windbreak, quick grower specimen, blends well with exotics. Attracts insect-eating birds, and beetles.

DISTRIBUTION: Qld. NSW. ACT. Vic.

Leptospermum phyllicoides (opposite)

One of our tea-trees with special horticultural value as noted above. Reproduced from "Grow What Tree" by The Australian Plant Study Group, published by Thomas Nelson Australia at \$29.95. This book is available from The Editor, Australian Plants for \$28.00, post free, for orders received before April, 1986. Also available from The Editor are others in this series, "Grow What Where", "Grow What Basic" and "Grow What Wet", each costing \$19.95.





Helicia

A genus in the plant family Proteaceae

by D. B. Foreman, National Herbarium of Victoria,
Royal Botanic Gardens, Birdwood Avenue, South
Yarra, Victoria.

In a recent issue of *Australian Plants* (Sankowsky 1983) a number of north Queensland rainforest Proteaceae suitable for cultivation were briefly described. Amongst those which were mentioned were three species of the genus *Helicia*. There are at the present time eight species of *Helicia* known to occur in Australia, however, further exploration particularly in north-eastern Queensland may well reveal several more species.

One species which is wide spread in northern Australia, namely, *H. australasica*, also extends to Papua New Guinea. Although the genus *Helicia* probably had its origin in the Australian region, it is in New Guinea that it has reached its greatest diversity with over fifty species, including a number of yet undescribed entities being recorded from the region.

Helicia species are usually found in or at the edge of rainforest on a wide range of soil types with the southern most limit for the genus being Minnamurra Falls on the south coast of New South Wales.

The species of *Helicia* are usually shrubs or small to medium sized trees which can grow up to 20 m tall in rainforest conditions but would be considerably smaller if grown in the open. The leaves are usually spirally arranged and with entire or variously toothed margins. The flowers occur in pairs as in *Grevillea*, for example, and are borne in axillary, more or less densely flowered, raceme-like inflorescences. The flower buds are straight with four tepals which separate and roll backwards as the flower opens (as shown in the colour plates on page 228). Each tepal bears a single anther on a very short stalk, located in the swollen distal portion of the flower, termed the limb. Each flower has four nectariferous glands at the base of the ovary which may be fused together or free. The fruit of all the Australian species as far as is known are more or less ovoid in shape, dark blue in colour when mature, usually contain only one seed, do not split open and are usually about 1 cm in diameter.

Following are brief descriptions of the species along with some comments on their potential horticultural value and propagation methods.

Helicia australasica is wide spread in northern Australia and extends into the Western Province of Papua New Guinea. It is most commonly found growing along the banks of small watercourses. The leaves are variable from oblong, elliptic-oblong, lanceolate to oblong-lanceolate (6-23 cm × 4-8.5 cm) and are usually glabrous. The inflorescence is 7-17 cm long and has a sparse covering of short reddish hairs. The flowers have stalks 1-3 mm long, have a thin covering of short reddish hairs, are cream in colour and are 8-15 mm long. Flowers July to November.

Helicia blakei is a rather rare plant so far known only from the Boonjie and Mt. Bellenden-Ker region in north Queensland. The leaves are glabrous, narrowly elliptic to more or less lanceolate (5.5-12.5 cm × 2-4 cm). The inflorescence is 8-14 cm long and sparsely covered with short reddish hairs. The flowers have stalks 4-5 mm long, are sparsely covered with short reddish hairs, are dull yellow in colour and are 15-17 mm long. Flowers in August.

Helicia ferruginea is found in a relatively restricted area on the north coast and nearby ranges of New South Wales and extends to south-eastern Queensland. The leaves are lanceolate to oblong-lanceolate with a regularly toothed margin (9-35 cm $\times$ 3-9 cm). The young leaves are covered with reddish or reddish brown hairs which persist only on the lower surfaces of older leaves. The inflorescence is about 8 cm long and has a dense covering of reddish brown hairs. The flowers have stalks 1-2 mm long, have a dense covering of reddish-brown hairs and are about 6 mm long. Flowers from July to November.

Helicia glabriflora is widely distributed from Minnamurra Falls on the south coast of New South Wales to the central coast and nearby ranges of Queensland. The leaves characteristically have very short stalks, are glabrous and oblong-lanceolate to more or less elliptic (5-16 cm $\times$ 1.5-4.5 cm). The inflorescence is 4-10 cm long and is glabrous. The flowers are glabrous, have stalks up to 3 mm long, long in colour from cream to pink and are from 8-13 mm long. Flowers June to February. See the photograph on page 228.

Helicia grayi is known only from a few localities near Mt. Lewis in north Queensland. The leaves have very distinct petioles, are glabrous, narrow-elliptic to oblanceolate (7.5-13.5 cm $\times$ 2-4 cm). The inflorescences are 6.5-12 cm long and have a sparse covering of reddish-brown hairs. The flowers are glabrous with stalks up to 5 mm long, they are cream in colour and up to 18 mm long. Flowers from May to August.

Helicia lamingtoniana is apparently restricted to the Atherton Tablelands. The leaves are covered with short reddish-brown hairs particularly on the lower surface and are more or less orbicular (6-9 cm $\times$ 4-9 cm). The inflorescence is 7-9 cm long and has a dense covering of dark reddish hairs.

The flowers have stalks 2-5 mm long, have a dense covering of short reddish hairs and are 12-18 mm long. Flowers July to August.

Helicia lewisensis is known only from the Mt. Lewis area of north Queensland. It is somewhat similar to *H. lamingtoniana* and *H. nortoniana* but with almost glabrous leaves and different flower characteristics. The leaves are broadly elliptical with a few irregular teeth on the margin (7.5-15.5 cm $\times$ 3-7 cm). The inflorescences are 9-11.5 cm long and are sparsely covered with short reddish brown hairs. The flowers have stalks 5 mm long, have a very sparse covering of reddish hairs and are 15 mm long. Flowers October to April.

Helicia nortoniana is found mainly in the Atherton Tablelands area but extends to just south of Cooktown. The young leaves are completely covered with reddish brown hairs, however, they persist only on the lower surface particularly on the midrib and main veins. The blade is ovate-elliptic to oblong-lanceolate with irregular teeth (5.5-14 cm $\times$ 2-6.2 cm). The inflorescences are about 10 cm long and are covered with short, dense, reddish brown hairs. The flowers have stalks 1-2 mm long, have a dense to sparse covering of reddish hairs, they are creamy-brown in colour and 8.5 mm long. Flowers April to January.

Editor's Note: The article is continued on page 230 as "*Helicia* In Horticulture" after the colour plates on the next two pages. We need colour slides of other *Helicia* especially *Helicia grayi*, *H. ferruginea*, *H. lamingtoniana* and *H. australasica*. Who will go to the trouble of getting them for us?

Rainforest Proteacea: Studies are being made of these plants. We would like to hear from any reader who can help or can take good colour slides.



Helicia glabriflora, the inflorescence $\triangle$ the flower ∇





***Helicia nortoniana* (above)**

Photography by Bob Jago

A small tree of the rainforest of the Atherton Tablelands, north to Cooktown.

***Helicia glabriflora* (opposite)**

The upper photograph shows the racemes of flowers and the lower one the flowers after the tepals have separated and rolled backwards.

Helicia in Horticulture

Of the eight species briefly described above two stand apart as having outstanding potential as garden plants. Firstly *H. ferruginea* for its attractive foliage and secondly *H. grayi* for its exceptionally prominent flowers. Both *H. lamingtoniana* and *H. nortoniana* have rather attractive foliage which combines well with the bright blue fruits.

The problem with all these species is that they are not common and often occur in restricted areas which could make initial collections difficult but not impossible.

H. glabriflora and *H. australasica* both have the advantage of being fairly common and wide-spread. Both these species have young leaves which tend to be an attractive and rather distinctive purplish colour. The flowers although relatively small in both cases are usually produced in profusion and fruit set is often quite high.

The dark blue fruits of all the Australian species do make an attractive display and are known to be eaten by various birds.

All the species have the advantage of flowering and fruiting when quite small and many besides flowering on current growth also produce a considerable number of inflorescences on old wood.

H. australasica, *H. glabriflora* and *H. grayi* have all been successfully grown from cuttings. No special methods were employed and any of the standard treatments would be worthwhile trying. *H. australasica* and *H. glabriflora* have both been raised successfully from seed. It is recommended that the seed be removed from the fruit before planting otherwise it tends to rot. Plants would probably do best on loamy well drained soils. Young plants may need some shade until they have become established. ■

REFERENCE:

SANKOWSKY, G. (1983). North Queensland Rainforest Proteaceae suitable for cultivation. Australian Plants. 12 (97): 208-209.

BOOK REVIEWS

What Garden Pest Or Disease Is That?

by Judy McMaugh

General garden queries to the Dept. of Agriculture, NSW, are handled by their Principal Horticulturalist, Judy McMaugh. This large book of 310 pages (28 × 200) will solve all your garden problems. Most common natives are dealt with together with the hundreds of exotics giving details of what problems are usually found. A separate section illustrates the annoying spots or the offending creature and describes methods of control. It is clear that Judy considers prevention is better than control and the introduction to the book is devoted to good garden practices. Available from your bookseller for \$39.95.

Australian Native Gardening — Made Easy

by Dick Chadwick

This is the latest of so many books aimed at the home gardener who has little or no experience in the garden, especially with our Australian wildflowers. This one is possibly different in that the text is written in an easy friendly style and the advice is very practical, almost as though Dick Chadwick was beside you giving a friendly hand. The plants recommended and illustrated in the 480 colour plates, are carefully chosen to be of greatest value in your garden. It is available from your bookseller for \$29.95.

Australian Terrestrial Orchids

by Collin and Dorothy Woolcock

The colour plate on page 221 is reproduced from this book, the best reference available on our terrestrial orchids. The pattern of the book is to carry simple language descriptions of 185 species, opposite large colour plates, a feature of the book, from colour prints by Collin Woolcock. The book is available from The Editor, Australian Plants, for \$40.00, post free.

Sturt's Desert Pea

Propagation by
Allan Black

The Sturt Desert Pea is one of our most spectacular wildflowers and I find, simplest to grow. My propagation methods may be of interest. I prepared a number of 50 mm plastic pots, which I filled with about 60% of an excellent commercial pot mix, and the balance with a seed raising mixture (not the sandy type), allowing for a small margin at the top to cover the seed with vermiculite for aeration. This medium was moistened.

I placed the dry seed in a shallow tray over which I poured very hot water (not boiling), and they were allowed to stand for 24 hours. The seed that was swollen was removed and three seeds placed on top of the seed mixture in each pot. These were covered with vermiculite to the top of the pot, firmed gently and watered. The hot water treatment was repeated on seed that was not swollen. The pots were stood in a steel tray and placed in full sun and covered with wet paper. The paper was replaced every day, depending on weather conditions. Double thickness of the paper was used on hot days. In warm weather germination should be apparent in about five days.

To grow-on the plants I have used 5 gallon drums but prefer 150 mm diameter earthenware drain pipes (hard to obtain now) about 460 mm long. They are stood upright on bricks on a 250 mm gully grating. In the bottom of the container standing on the top of the grating I added crocks for drainage. The containers were filled with the same commercial pot mix as for the 50 mm pots, but I added about 5% of German peat moss. I am not aware of the ingredients of this mix, but suspect a predominance of crushed pine bark, but its greatest advantage is that it provides 100% drainage, is light, holds moisture well, and so requires less watering.

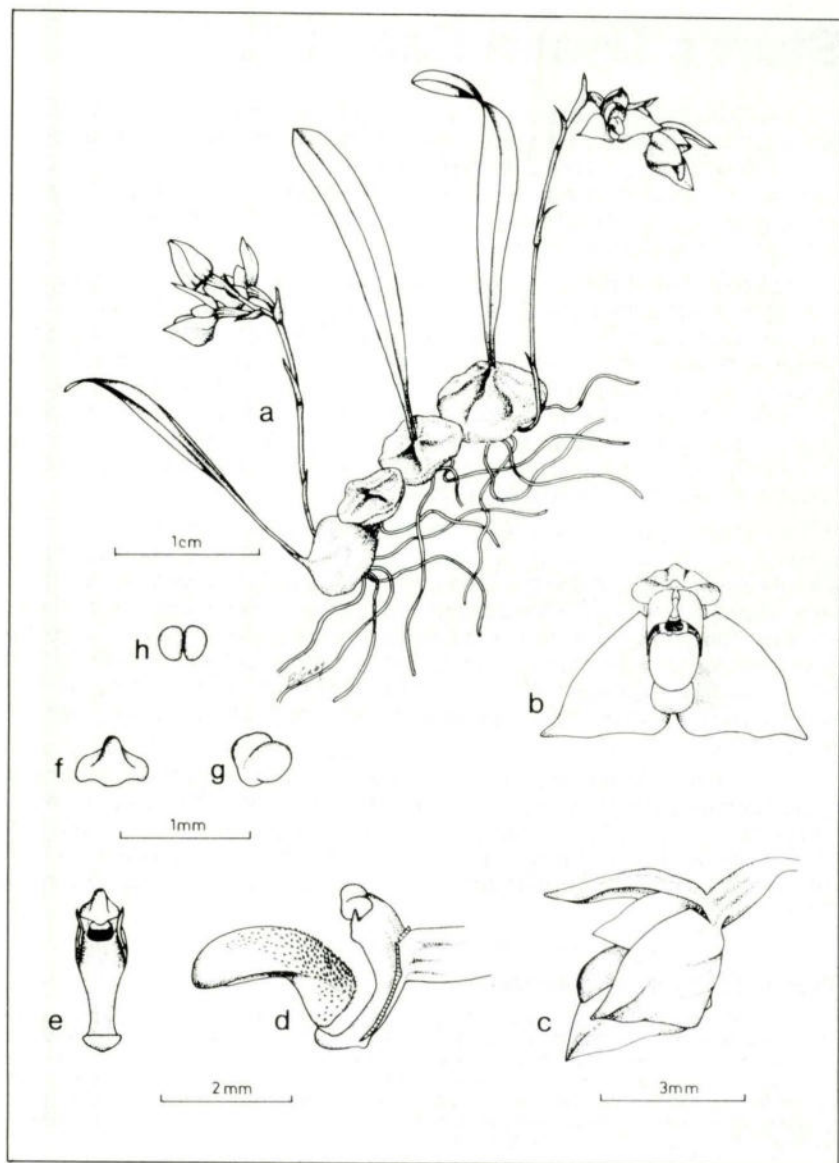
When seedlings are about 25 mm high, and having soaked the small pots in water I tip out the contents carefully and plant the whole root ball into the prepared containers. They are then firmed gently, but not tightly then watered. I watered them every day in hot weather, and once a week I apply Thrive fertilizer at half recommended strength. As the seedlings progress I removed the retarded ones, if any. ■

Tropical Orchids of Australia

by Bill Lavarack and Bruce Gray

There are some 230 species of orchid that occur in the Australian tropics. How easy are they to grow? Few realise the range of habitats included in the Australian tropical areas. The exceptional value of a new book with the above title is the description of these habitats, the classification of the 230 species of orchid into these habitats and the conclusions reached for each species in turn as to the correct method to be adopted for their cultivation. This type of information based on competent observation, assessment and first hand experience with cultivation of so many orchids has never been available previously. This review is continued on page 236.

The paragraph above is by The Editor, Australian Plants. To adequately present such a review it is desirable also to reproduce portions, by permission, and this is done below. Features of the book are the colour plates and that of *Dendrobium fleckeri* is reproduced on page 236. New species not described in the original edition of "Australian Indigenous Orchids" are included to update that valuable reference. One of these descriptions with a large full page sketch and colour plate follows: (See also page 236).



Bulbophyllum boonjee B. Gray and D. L. Jones: a, Habit; b, Flower from front; c, Flower from side; d, Labellum and column (petals and sepals removed); e, Column from front; f, Anther from front; g, Anther from back; h, Pollinia.

This line drawing and the colour plate opposite are reproduced from "**Tropical Orchids of Australia**" by The Australian Plant Study Group, published by Thomas Nelson Australia at \$49.95. This book is available from The Editor, Australian Plants, post free for orders prior to March, 1986.



Bulbophyllum boonjee

Plant epiphytic, growing in small clumps. Rhizomes short-creeping. Pseudobulbs crowded, globular to depressed globular or conical, pale green, 5-8 mm × 4-5 mm. Leaf ± erect, 20-42 mm × 4 mm, linear-lanceolate, ± petiolate, pale green. Inflorescence 15-30 mm long, with two to four flowers. Peduncle filiform, with two to three small, spreading bracts. Pedicel plus ovary 3-4 mm long. Ovary smooth. Flowers 4-5 mm × 6-7 mm, dark maroon, with three distinctive nerves on the sepals. Dorsal sepal 3-4 mm × 1-2 mm, cucullate, ovate, acute. Lateral sepals 3-4 mm × 2.5-3.5 mm, broadly triangular, spreading. Petals 2-3 mm × 1-2 mm, ovate-acute, curved inwards and enclosing the column. Labellum 2.5 mm × 0.8 mm, curved, thick, blunt, oblong to linguiform, maroon throughout, tuberculate on the proximal part of the upper surface. Disc slightly ridged. Column 1-1.5 mm long. Column foot about 2 mm long, curved throughout. Stelidia short, entire, pointed. Anther cap about 0.5 mm × 0.6 mm, with a very short, truncate rostrum and a prominent dorsal ridge.

Bulbophyllum boonjee appears to be a rare species, at present known only from the type locality in the Boonjee area on the eastern side of the Atherton Tableland at an elevation of 720 m. It occurs in small, discrete clumps, each consisting of a few pseudobulbs, and grows on the upper branches of trees in dense rainforest. Flowering occurs from September to February.

This species belongs to the section *Macrouris* and is related to *B. lageniforme* and *B. newportii*. It is closest to the former, differing in its smaller habit, the much smaller, deep-maroon flowers and the distinctly tuberculate labellum. *B. newportii* has a papillose labellum but can be readily distinguished from the above by its long-creeping rhizome and widely separated pseudobulbs.

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Acacias of New South Wales — by I. Armitage. Normally \$12.00.

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Dendrobium fleckeri

Tropical Orchids of Australia

by P. S. Lavarack and B. Gray

Australian Indigenous Orchids by A. W. Dockrill has always been the worldwide reference to the epiphytic orchids of Australia. Since its first publication, there have been many new species described for Australia. Pending the full review of Australian Indigenous Orchids, Bill Lavarack and Bruce Gray were commissioned to produce a colourful book describing all the new species. If you are lucky enough to have a copy of Australian Indigenous Orchids, you do not need one when revised next year. Your old one is fully updated with this book.

"Tropical Orchids of Australia", however, stands on its own as a valuable reference to Australian Orchids. It provides the only complete and accurate guide to their conditions of growth in nature and a very competent translation into the requirements for cultivation.

The above colour plate is reproduced from "**Tropical Orchids of Australia**" by P. S. Lavarack and B. Gray, published by Thomas Nelson Australia at \$49.95. This book is available from The Editor, Australian Plants, post free for orders prior to March, 1986.