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Colour photography by L. Sourry

THELYMITRA VENOSA—"Veined Sun Orchid"

An orchid of the alpine bogs of the eastern highlands but occasionally on coastal heathlands of Tasmania, S.A., N.S.W. and Victoria.

AUSTRALIAN TERRESTRIAL ORCHIDS FROM SEED—See page 250

WILDFLOWERS FOR GROUND COVER AND ROCKERIES

GROWING WILDFLOWERS

This periodical is devoted to the preservation and cultivation of the Australia flora. This issue has been compiled by members of the Canberra Region, indexed below. As Volume 6 nears completion this page, in association with a list of contents of the issue will give references to previous articles on the same subject.

LANDSCAPING—MULCHING, GARDEN SURFACE DRESSING

An essential part of landscaping is the dressing of the ground area for a pleasing effect and a background for the floral and foliage display. For best culture of the mostly surface rooted natives, the top soil should be covered to keep it cool, moist and viable. This can be done with a covering of stones, pebbles, gravel or a mulch of leaves, wood chips, etc., as described in previous issues 12:2, 18; 13:13, 15; 33:211; 35:313; 41:212. Areas can also be covered by plants.

NATIVE GROUND COVERS—The article opposite provides results of experiences at the Canberra Botanic Gardens and although this is a project on a grand scale, the plants used may be used equally well in the home garden.

Previous issues have considered this aspect and a review may be timely. The article opposite has divided the situations into four categories. For each of these categories (in addition to the plants described in this issue) the gardener will want to select plants from the following growth forms.

SUCKERING PLANTS—In some situations it is necessary to be wary of some vigorous species—12:14, 16; *Phyla (Lippia), Lotus, Commelina, Viola.* Species that are vigorous—Magnificent displays by plants belonging to the family *Goodeniaceae* are described in issue no. 42.

Other safe suckering ground covers are described in 12:14, 16; 37:13.

GROUND HUGGING PLANTS—Vigour depends on exposure, moisture, viability.

Creepers—Some are a problem because of their tendency to climb shrubs and trees and for this reason the article opposite divides them into situations (a) and (b). They are often not a real problem for a home gardener who has the interest to train and prune. Some may be vigorous to pest proportions in good situations, such as *Kennedya rubicunda,* but in a more hardy situation where other plants have difficulty in surviving, it has proved an ideal plant. 12:15, 16, 21; 33:199, 226, 228; 36:36; 40:182; 45:13.

Succulents—19:217; 22:84; 23:111.

Small Low Spreading Plants—See also Rockery Plants below. 12:13; 23:98, 101. 102; 46:56, 67; 47:150.

Plants with a Large Spread—Many low growing plants have forms that hug the ground. The most widely used plants for this purpose are *Grevillea.*

Low Growing Plants—Some height is often desired, how much depending on culture, pruning and exposure. These are usually described and recommended for rock gardens, see below but two genera of plants widely used are: Grevillea—Low growing and prostrate—issue no. 29 is principal reference 45.4. Acacia—Wattles—23:104, 29:32, 35:317.

Rockery Plants—While all plants recommended for rockeries are not suitable as ground covers, they are low growing. Sun, exposure and moisture are usually more important. In association with some rocks or gravel mulch they will serve as colourful ground cover in patches. The following references supplement issue no. 23 which is principally devoted to the subject—19:217; 25:218; 29:6, 7, 10, 13; 32:156; 33:205; 37:13; 42:213, 243; 43:308; 44:381. Special plants—9:31; 23:106; 23:109; 29:29; 33:205.

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NATIVE GROUND COVERS

by J. W. Wrigley, Curator, Botanic Gardens, Canberra

Insufficient thought is usually given to the selection of ground covers when setting out a landscape. Let us look at the factors which should be considered in this selection.

(1) What spread is required?

Many times we have seen species used which are too vigorous for a situation and which have completely swamped the surrounding shrubs. Repeated pruning may overcome this excessive growth but it is easier to make the right choice in the first place. Sometimes the reverse is true and the ground is not sufficiently covered. This may be caused by either incorrect spacing or poor selection of species.

(2) Are there trees in the area?

If trees or shrubs are present, then care must be taken to select plants which won't climb into them, unless, of course this overgrown effect is required. However, they may afford shelter from frost for certain borderline species in colder districts. This gives the landscaper a wider choice.

(3) What height is most desirable?

From a purely aesthetic point of view it adds interest to large expanses of ground covers to vary the height. The landscaper should not consider a ground cover to be essentially a prostrate plant. It may be 4 or 5 ft. tall but still hug the ground over a wide basal area and serve the purpose of a ground cover. From a more functional aspect it may be desirable to use a taller species to hide an unsightly structure such as a septic tank or even to divert wind from a certain area.

(4) What is the aspect?

This is an obvious question but one that is sometimes forgotten. Some plants thrive in the full western sun others prefer the shade of a southerly aspect.

(5) Is frost a problem?

Those of us resident on the tablelands of N.S.W. realise the importance of this question and considerable experience is being gained at Canberra Botanic Gardens in this regard. If the situation is exposed to severe frosts then the selection of species is limited. If in this article, a species is recorded as frost hardy then it has withstood grass temperatures down to 20°F.

(6) Is the drainage good?

With the everpresent danger of *Phytophthora cinnamomi* (root rot) attacking plants in poorly drained situations, this factor should be considered. If the drainage is poor then either efforts should be made to improve it or plant selection should be limited to those species which have shown some resistance to the disease.

(7) Is regular watering possible?

In this article it is proposed to consider a variety of sites and select suitable native species for these. In so doing, the above seven factors will also be considered and it will be left to the landscaper to make his choice.

(a) SLOPING BANKS WITHOUT TREES OR SHRUBS

All species mentioned in this section should not be used when trees or shrubs are in the area as they tend to become tangled in the branches rather than stay on the ground.

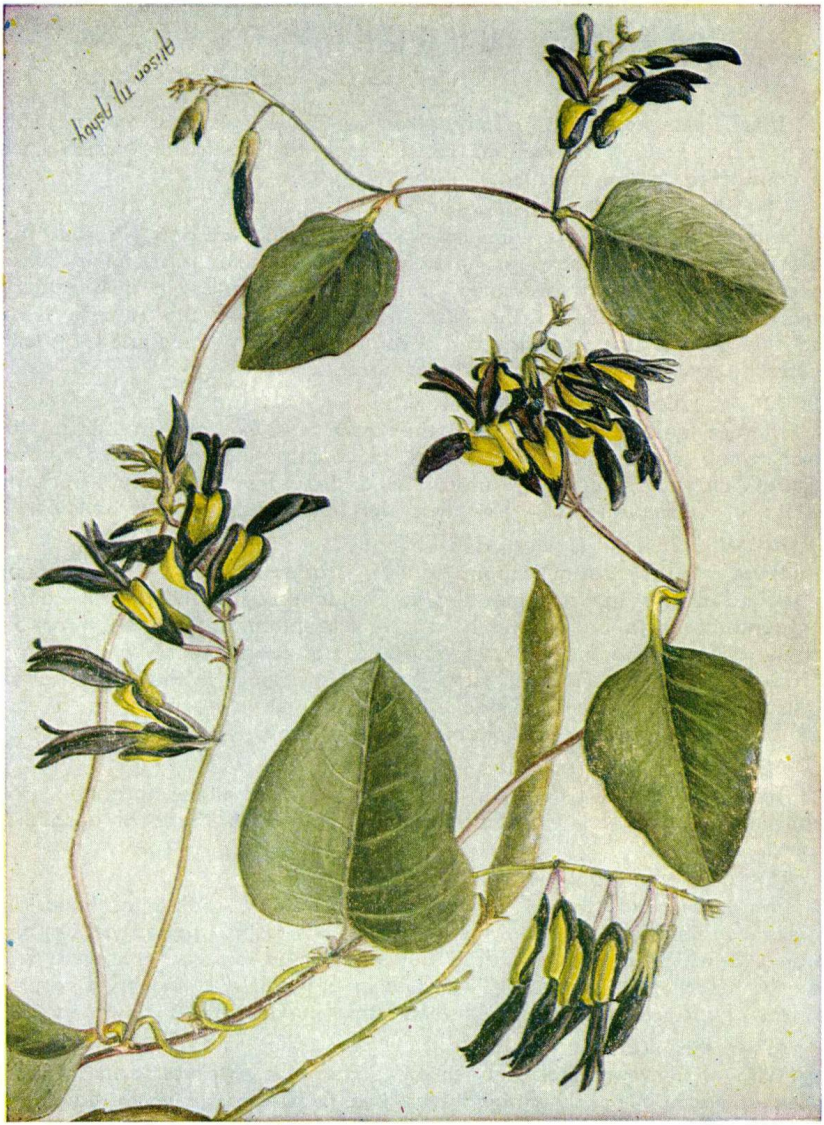


Plate by courtesy of South Australian Museum who can supply copies.

Kennedia nigricans. A very vigorous creeper from W.A. with unusual black and yellow pea flowers and large handsome deep green leaves. One plant will cover an area of 20 ft. diameter in a season if conditions are good. It is more frost hardy than most other Kennedias although its foliage suffers some damage after heavy frosts in Canberra. Leaf damage may also be caused by snails which should be controlled with the usual snail baits.

Propagation is by seed or cuttings taken in September. Seed should be scarified before sowing. Regular watering would be required for good growth.

(Continued on page 242)

LANDSCAPING WITH WILDFLOWERS

The "everlasting" flower plant below is presented as part of the complete article on "Native Ground Covers" and belongs in the group (c) on page 247. However special attention is drawn here to its value as a feature or form plant in a landscaping scheme.



Helichrysum hookeri. A Snowy Mountains species which so far is not known in general cultivation. It is low and compact, forming a rounded bush about 18" high. In mass planting it should be used at 2 ft. centres as it is reasonably slow growing. Flowers are cream and cover the bush in late spring and early summer. The minute leaves give the plant, out of flower, the appearance of a dwarf conifer.

Propagation is easy from cuttings.

The species is frost hardy and requires moderate watering and reasonable drainage. No pests have been observed.

Continued from page 240—

Kennedia macrophylla. This W.A. species is almost as vigorous as *K. nigricans* but has red flowers of the more "conventional pea flower" shape. Leaves are slightly smaller, paler and less glossy than the former species. Its frost hardiness has not been fully determined as its present location at the Botanic Gardens affords it some shelter.

Propagation is by cutting or scarified seed. No pests noticed.

Moderate watering required for good growth.

Kennedia rubicunda. An eastern species which is becoming well known in cultivation, but which is not as attractive as the two former species. Red flowers are similar in form to *K. nigricans. K. rubicunda* is frost tender and although not being killed is badly damaged and appears very unsightly by the end of winter. The species will withstand drier conditions and will survive once established with little or no artificial watering under Canberra rainfall conditions (avge. annual 26 inches).

It is moderately vigorous (10 ft. centres) and may be propagated from cuttings or scarified seed. No pests have been recorded.

Kennedia coccinea. One of the most beautiful of the Kennedias, this species is native to south western Australia where it covers fallen logs and low trees and shrubs. Its flame red flowers are held upright in Spring and its dainty foliage is less robust than other species mentioned. Its resistance to frost has not been fully tested but under some shelter it suffers no damage.

In bank planting the suggested spacings would be 5 feet centres. Moderate watering is required to maintain the species in good condition.

Propagate from scarified seed or cuttings. No pests recorded.

Hibbertia dentata. Another east coast species which although frost tender is a delight in a sheltered situation or moderately frost free area. Its yellow flowers 2" in diameter are well presented over a long period. Foliage is attractive and develops a purplish tint in the colder months.

In mass planting, plants should be spaced at 4 ft. centres as the species is not as vigorous or densely growing as the Kennedias.

Propagation is from cuttings.

No pests have been recorded.

Moderate watering and good drainage is recommended for best growth.

Hardenbergia violacea. This plant ranges over a wide area of the coast and mountains of Eastern Australia. It is a frost hardy species which requires good drainage and relishes dry conditions. Flower colour is generally purple, but pink and white forms are not uncommon. Shrubby forms also exist but for ground cover work on sloping banks, care must be taken to select the trailing form. Plant at 4 ft. centres for dense coverage.

Propagation is best from scarified seed, although for preservation of particular colour forms take cuttings in December.

Apart from the odd caterpillar the species is generally free of insect damage. Care must be taken with drainage as losses from *Phytophthora cinnamomi* (root rot) have been recorded.

Billardiera scandens. The genus *Billardiera* belongs to the *Pittosporum* family and includes a number of species useful as climbers or ground covers. *B. scandens* is an east Coast species which is the most easily available but by no means the most attractive. It has however, the virtue of being frost resistant and hardy. It seems to accept a variety of conditions from dry to moderately damp and from full sun to almost full shade. It is not vigorous and should be planted at 2-3 ft. centres for dense coverage.

The fruit is succulent and edible and propagation is easy from seed or cuttings. The species appears to be pest free.

(B) SLOPING BANKS WITH SOME TREES OR SHRUBS

The species mentioned in this section all have a considerable spread but tend to stay on the ground rather than become entwined in shrubs and low hanging trees.

Kunzea pomifera. A native of S.A. which demands perfect drainage for good growth. Feathery white flowers borne in late spring and early summer are attractive and the shiny, stiff, small round leaves make the plant an all the year favourite.

It is frost hardy and readily propagated from cuttings.
root rot will follow. Space at three feet centres for mass planting.

Space at three feet centres for mass planting.

Grevillea biternata. This W.A. plant is becoming well established as a valuable ground cover for banks in exposed situations. Good examples of its use may be seen on the Sydney-Newcastle expressway. Its white flowers in Spring hide the foliage which is attractive in its own right.

Good drainage is preferred and full sun encourages best flowering.

Propagation is easiest from cuttings.

The plant responds well to trimming and if an occasional branch tends to grow vertically it may be cut off at the base.

Grevillea laurifolia. From the Blue Mountains, N.S.W. comes this red flowered, "toothbrush" Grevillea. In time, a single plant will cover over 20 feet square but the species is slow to start and usually requires a couple of seasons to settle down before a good growth is attained.

Propogate from cuttings in late summer.

It is frost hardy and does well in full sun.

The species is completely prostrate and has hybridised naturally with G. *acanthifolia,* producing G. x *gaudichaudii,* a ground cover which seems to be faster growing than G. *laurifolia,* producing a good cover with more attractively shaped leaves but less dense habit.

Grevillea thelemanniana. At least two forms of this species are in cultivation; one is a grey leaved form with loosely growing, long, prostrate stems and another with pale green foliage, slightly more upright and generally more compact. The flower colour on the second form is a paler red and does not show out as well. The grey leaved form is the more desirable but is definitely the more frost tender.

Easily grown from cuttings in Summer and prefers good drainage.

For dense coverage, space at 3 ft. centres. No pests observed.

Phyla nodiflora (syn. *Lippia nodiflora).* From the east coast sand dunes comes this rapid growing verbena like plant with its small pink flowers and bright green leaves. It is a prolifically growing plant rooting at the leaf nodes and care should be taken that it is positioned away from garden beds where it is likely to become invasive.

It has been used successfully as a lawn and at the Canberra Botanic Gardens has proved highly successful in bank stabilisation. It is moderately frost hardy although growth ceases in the winter months.

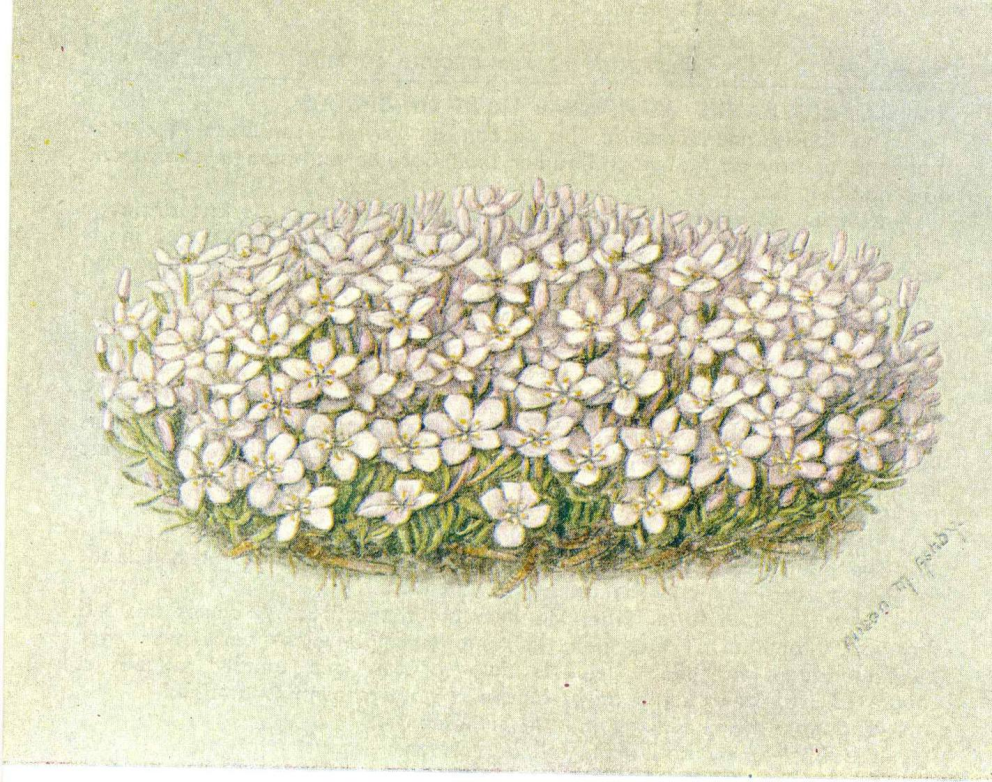
Propagation is most easily achieved by chopping up runners and planting as one would grass runners.

Water consistently during the warmer months.

Kennedia prostrata. Common right across the Continent this species is one of the few Kennedias that stays on the ground. It is frost tender and will only survive under shelter in Canberra. It forms a tight mat and is fast growing in a sunny situation although the red flowers are often hidden.

Propagation is from scarified seed or cuttings.

Space at 6 ft. centres. No pests have been observed.







GREVILLEA BAUERI

Grevillea—after C. F. GREVILLE, a patron of botany and once vice-president of the Royal Society of London. *Baueri*—after the German brothers Bauer, botanical illustrations. Colour plate by courtesy of Canberra Botanic Gardens.

Prostrate form—vigorous grower for a large space, with stiff dense growth in arching sprays. Young tips are copper coloured. Height 3 ft., spread 6 ft. See page 247 for ground cover where some height is desired.

COLOUR PLATE—UPPER LEFT:

Neopaxia australasica (Hook. f.) Nilsson. Portulacaceae. Drawing by Alison Ashby of a specimen at Charlotte Pass, Kosciusko State Park, N.S.W., 6,000 ft. Found also in Victoria, South Australia, Western Australia and Tasmania—three-fifths full size—copies of this picture may be obtained from the South Australian Museum to whom we are indebted for these blocks.

Neopaxia australasica (syn. *Montia australasica).* This is a plant which thrives in wet conditions and in fact may even be grown as an aquatic. It is useful as a soil binder but in the colder areas tends to disappear below ground in the winter months. With bright green grass-like leaves, and small white star-shaped flowers it is useful for around ornamental pools. It does tend to become invasive and care should be taken to isolate it from areas defined for annuals etc.

Propagation is by root division and plantlets may be positioned directly provided adequate watering is carried out.

COLOUR PLATE—LOWER LEFT:

Scaevola hookeri (De Vriese) F. v. M. ex Hook f. Goodeniaceae. Drawing by Alison Ashby of a specimen at Guthega Dam, Kosciusko State Park, N.S.W., 5,400 ft. Three-fifths natural size. Found also in Victoria and Tasmania, Scaevola are ideal rockery plants—see page 272.

Cassia odorata (prostrate form). A form of *Cassia odorata* from the South Coast of N.S.W. exhibits a completely prostrate habit making it eminently suitable for ground cover work. Unlike many other Cassias it has shown itself to be moderately frost hardy in Canberra and reasonably quick growing. With masses of yellow flowers in late Spring and early Summer it is an eye catcher for a sunny situation. A plant will cover about 4 feet in the first two growing seasons.

Propagation is from seed and no pests have been noted.

Myoporum debile. An inland species sometimes found naturalised on coastal areas and thought to be introduced by cattle. It is slightly frost tender in Canberra but recovers to flower through the summer and fruit in the Autumn. Flowers are small and white but the fruits are red to purple and quite showy.

Propagation is easy from cuttings.

For a dense coverage 2' to 3' centres is recommended. No pests.

Mentha diemenica. Little has been done with our native mints in cultivation but this species is worthy of trial. Being native to the local area (A.C.T.) it is frost hardy and thrives on ample watering. Its blue flowers are borne in Summer, and may be propagated from cuttings or root division.

Plant at 18" centres. No pests noted.

Hibbertia scandens. A vigorous creeper of the east coast sand dunes but one which will survive in Canberra only with winter covering. Its large showy yellow flowers are up to 3" in diameter and appear right through the warmer months.

Propagation is by cuttings.

A well drained situation is required but adequate watering is also necessary. Plant at 5 feet centres on the coast and 3 feet centres under shelter inland. No pests noted.

Carpobrotus virescens. There are a number of Australian succulent plants suitable for ground cover work in extremely dry areas, the genera *Carpobrotus* and *Disphyma* being outstanding. C. *virescens* has purple flowers about 2" in diameter and can withstand grass temperatures to 20°F without damage.

Propagation is easy from cuttings.

Snails should be guarded against.

Suitable spacing would be 2' to 3'.

Synaphea reticulata. This species is included as a plant worthy of trial. Foliage is a pale green and flowers are sulphur yellow. A mature plant may cover densely a circle of 6 ft. diameter to a height of 9" to 12".

The genus *Synaphea* has been largely neglected in cultivation. Let us remedy this in the future.

(C) AREAS WHERE SOME HEIGHT IS REQUIRED

Bauera rubioides. Well known in sheltered damp situations along the east coast, this shrub has proved extremely adaptable in exposed full sun positions in Canberra. In such a location, the height is restricted to about 2 feet with a spread of at least 5 feet. The species flowers for long periods and is one of the most resistant we have yet observed to *Phytophthora cinnamomi*. The shrub appreciates adequate water but will withstand drought. It appears that good drainage is not important.

Propagation is by cutting at any time of the year.

Frost is not a problem and no pests have been observed.

In summary, this hardy species should be used in parks and gardens far more than it is at present.

Helichrysum hookeri—See colour plate, page 241.

Micromyrtus ciliata. This eastern species is variable and only the semi-prostrate form is suitable for ground cover work. It will spread to 5 feet and remain about 18" high. The white flowers fade to red and the bush remains attractive for many weeks. It is frost hardy, requires good drainage and apart from occasional attack by scale insects, pests are not a problem.

Propagation is from short tip cuttings taken in summer when new growth has started to harden.

Casuarina nana. One does not normally think of Casuarinas as ground covers but there are several species suitable for this type of use. C. *nana*, which grows in the Royal National Park near Sydney is one. Rarely more than 3 feet high and with a spread of 6 to 8 feet, it is tolerant of a wide variety of conditions.

Propagation is from seed. It is frost hardy.

Casuarinas make an interesting foliage contrast whether as ground covers or specimen trees and more use should be made of the genus in planning of parks and private gardens.

Acacia glandulicarpa. Several Acacias are useful ground covers because of their low spreading habit. This species is Victorian and at 2' 6" to 3' high has a spread of over 6 feet. It is spring flowering with a good covering of small golden balls. Propagation is from scarified seed, and some small successes have been had from cuttings. It is not worried by frosts.

It appreciates a well drained spot in full sun but, as with most Acacias, it is prone to borer attack.

Haloragis monosperma. Collected in the Budawang Ranges of southern N.S.W., this species is not common in cultivation. It is however, fast growing with bright green foliage and cream flowers in the Spring. Plants should be spaced at 6 ft. centres and expected height should be about 4 feet.

The species is frost hardy and may be grown easily from cuttings. No pests have been recorded but adequate water and good drainage should be provided.

Bracteysema lanceolatum. A red pea flower of W.A. and one which has become well-known in cultivation in the east. Its flowers are not well displayed but its glaucous foliage and spreading habit make it useful particularly for park work.

It is frost hardy and resistant to pests and diseases provided that reasonable drainage is effected.

Propagation is either from scarified seed or cuttings.

If conditions are suitable a spread of at least 8 ft. can be expected with a height of 4 to 5 ft.

Grevillea paniculata. Some forms of the W.A. plant tend to be low and spreading and are suited for ground covers. The species has prickly foliage and is useful for deterring animals or children. In flower it is a mass of cream, highly scented blossoms, but at other times its fresh light green foliage is attractive. Good forms will spread to 8 feet with a height of 3 or 4 feet.

Propagation is from cuttings, no pests have been noted and the species is frost hardy.

A sunny, well drained position will suit it best.

Grevillea baueri—See colour plate page 245.

(Continued on page 272)



Photography by J. W. Wrigley

ERIOSTEMON AUSTRALASIUS

Previously known as *Eriostemon lanceolatus*, this marvellous garden shrub has always proved difficult to propagate and grow. As described on page 256, we may have overcome our propagation difficulties so now we must turn to the cultivation problem. It has often been found that when plants can be propagated in reasonable quantities, wider planting finds a solution to the best cultivation methods—or is it that we develop plants more amenable to general conditions.



Photography by C. Hubner

ERIOSTEMON AUSTRALASIUS

These beautiful shrubs are found in light bush soils but respond best to friable soils in the garden. Large sandstone rocks on top as well as in the soil around the roots appear a key to successful cultivation seeming to indicate that firm anchorage against wind damage, and cool moist roots are essential. If the roots are kept moist and well drained, a sunny open position will give best results.

Refer to the rear cover to a closely related more readily grown plant.

PULTENAEA CAPITATA—Colour plate opposite

A beautiful ground cover plant as mentioned on page 273. The ironstone gravel mulch does not give good contrast in the colour plate but in a rockery this and a number of other pea-flowered plants, make quite a good show.

Australian Terrestrial Orchids from Seed

by D. K. McIntyre, G. J. Veitch and J. W. Wrigley, Canberra Botanic Gardens

Australian terrestrial orchids as a group have been largely neglected by fanciers in the past, although this group contains many delicate and beautiful species. Interest has been aroused in them recently because in some areas, urban and other development is destroying their habitat and some are in danger of disappearing from our flora.

Many terrestrials are easy to grow in cultivation from tubers, providing care is taken in watering and allowing them to dry out during their dormant period. This technique, however usually involves removing a plant from its natural habitat—a very undesirable practice. It is not possible to raise large numbers of many terrestrials vegetatively as some only produce one and sometimes two tubers a year.

By developing techniques for growing terrestrials from seed the loss of plants in the wild is avoided. The advantage of obtaining a wider genetic range for the species is exploited, and hybridising becomes possible.

The difficulty of growing terrestrials from seed is apparent from the lack of information available on the subject. Stoutomire (1963) successfully germinated several species in U.S.A., and Warcup (1971) has also germinated many species on artificial media in sterile culture while studying mycorrhizal associations. There is little information on later seedling growth and the important step of transferring seedlings from sterile to the non sterile soil conditions. Kowald (1970a and b) has apparently been able to raise some species from seed and transplant them into non sterile media, but further information regarding the success of these plants in non sterile conditions has not been published.

The following is an outline of methods developed at the Canberra Botanic Gardens over the last 18 months to successfully raise terrestrials from seed.

SEED

Seed is collected either as dry seed or in "green pods". Dry seed is placed in manilla envelopes, in sealed jars with silica gel and stored in the refrigerator until required.

Green pods, which have almost reached maturity but have not split, are collected and these are used immediately (preferably the same day). Seed from these pods is desirable as it does not have to be sterilised (only the outside of the pod needs sterilising), the percentage viability is very much higher, and there is no loss of seed viability in the hypochlorite. Careful study of the maturity time of pods has to be made for each species as it varies considerably.

SOWING DRY SEED

Dry seed is surface sterilised in a 0.5% solution of sodium hypochlorite, with a few drops of absolute alcohol as a wetting agent, for about 20 minutes, washed in sterile water, and then placed in sterile nutrient solution (Knudson's C without agar) in McCartney bottles and the lids screwed on tightly. The bottles are placed in the dark in an incubator at 25°C for about 2 months. When the seeds have swollen and obviously germinated, the bottles are taken out of the incubator and placed on a bench in the light near a window.

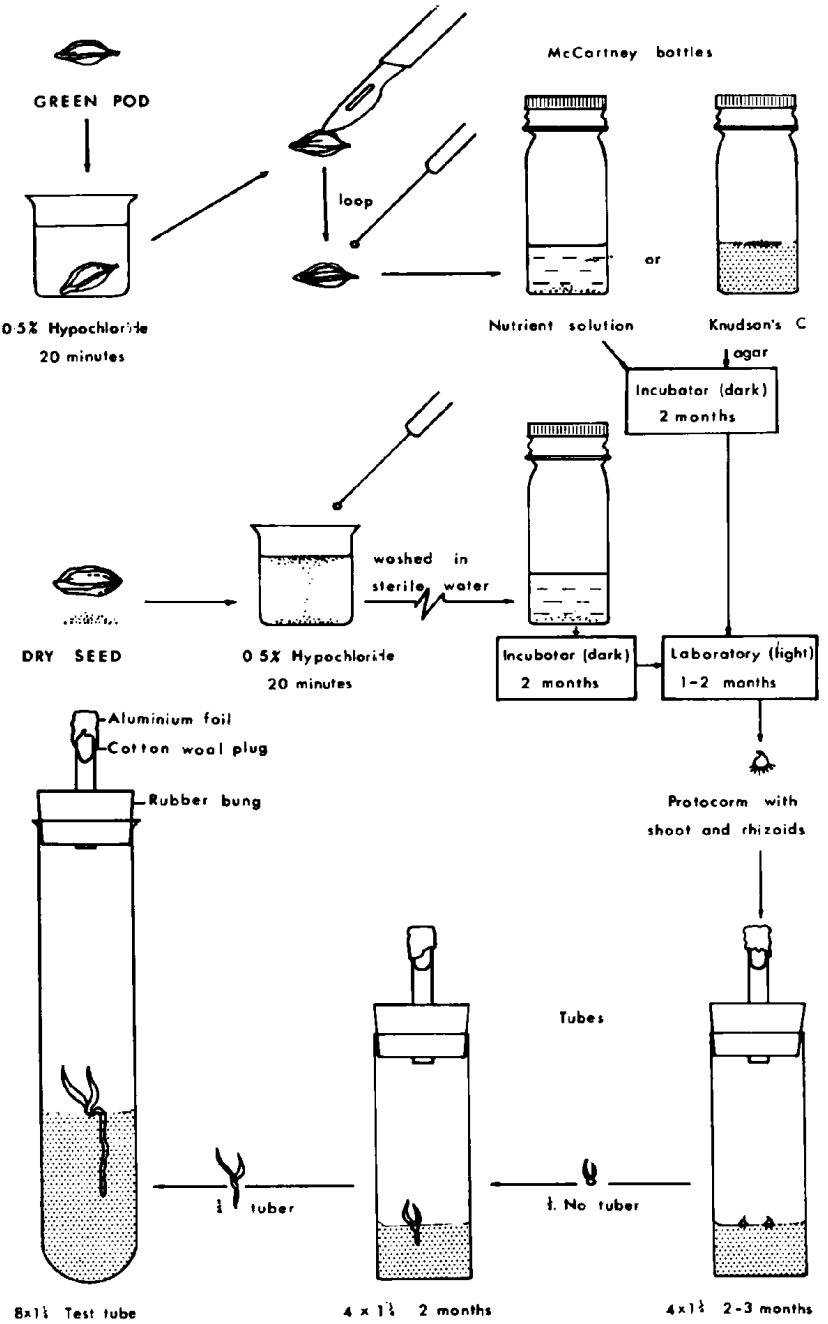


Fig. 1.—Two methods for germinating terrestrial orchid seed.

All processes shown in figure 1 are carried out in a Laminar Flow cabinet which provides a work area in a steady stream of sterile air, preventing contamination from air borne spores. The normal precautions of washing hands in alcohol and ensuring spores are not taken into the cabinet are still necessary.

SUN ORCHIDS



Colour photography by J. Glass

THELYMITRA ANTENNIFERA

"Rabbit-ears", "Lemon Orchid" or "Vanilla Orchid" are some common names of this widespread species from Vic., Tasm. and Western Australia where this plant is as photographed near Geraldton. Column appendages, dark coloured, long and clubbed, stand up like a pair of ears.

In the next issue 20 species of *Thelymitra* will be described with full details for their cultivation. The major problem (possibly even disgrace) is the availability of plants. The article opposite indicates that it involves a little bit of trouble but it is up to us to face this problem. How about groups of people from all parts of Australia going to this trouble and exchanging plants. Enquiries to the Editor.

After about two months in the light the protocorms usually begin to differentiate. They have rhizoids and a definite peak on one side, which is the first shoot. The protocorms are taken out of the solution with a pair of sterile watchmaker's forceps and placed, shoot up, on sterile Knudson's C agar in 4" x 1¼" specimen tubes fitted with rubber stoppers and small glass breathing tubes with cotton wool plugs, and aluminium foil caps.

Seeds from one batch do not all germinate at once, so the McCartney bottle can be resealed and left until a later date when more seed will germinate. The advantage of waiting until differentiation is obvious to the naked eye, is that the protocorm may be placed on the agar the right way up. If they are transplanted too early they may be planted the wrong way up and these may die or take a very long time for the shoot to orientate itself.

The young plants are left in these tubes for about two or three months, until shoot growth is about ¼" long, or until the plants have stopped growing. They are transferred to fresh Knudson's C agar in 4 x 1¼" specimen tubes where they remain for a further two months or until tubers have developed to about ¼" long. They are transplanted again into 8" x 1¼" tubes with about 2½" of Knudson's C agar.

The plants remain in these tubes until tubers reach at least 1" long (in the case of species with long tubers) and are then ready to be transplanted into non sterile soil.

It should be noted here that rather than retarding the plants by frequent transplanting onto fresh agar it is quite the reverse. When plants are put onto fresh agar they usually show very rapid growth after 2-3 weeks.

When tubers begin to develop they usually do so very quickly, sometimes up to ¼" in a week to ten days. More than 1" of shoot growth has been recorded in one month.

Green Pod or Embryo Culture

The green pod is surface sterilised in 0.5% sodium hypochlorite for 20 minutes. The pod is cut open with a sterile scalpel, the seed scraped out with a sterile loop and placed straight onto Knudson's C agar in a McCartney bottle, or into nutrient solution. If the seed is sticky the solution is preferable as they separate and are easier to handle at the later stages.

The bottles are placed in the incubator for about two months, transferred to the light until they are differentiated then transferred onto fresh agar or out of the solution onto agar. From this point onwards they are treated in the same way as germinated dry seed.

Transplanting Seedlings to Non-Sterile Soil.

The seedlings plus agar were carefully removed from the tubes. The agar was carefully removed from around the tubers by gently washing in luke warm water. Extreme care has to be taken at this stage as the shoot can be very easily broken off from the tuber.

The seedlings were then planted in 3" earthenware pots filled with U.C. mix (McIntyre 1971). The pots were placed in a humidity box (a wooden frame covered with clear polythene) on a sand covered bench in the glasshouse. The leaves regained turgidity and stood up after a couple of days. Care was taken not to overwater to prevent tubers from rotting. After about one week pots were watered with half strength Aquasol (0.5g/litre), and once a week with full strength Aquasol thereafter.

These plants have been growing in these conditions for 2½ months (at 1/12/71). There has been shoot growth on most plants and probably tuber growth as well. Tuber growth has occurred in at least one pot. The seedling

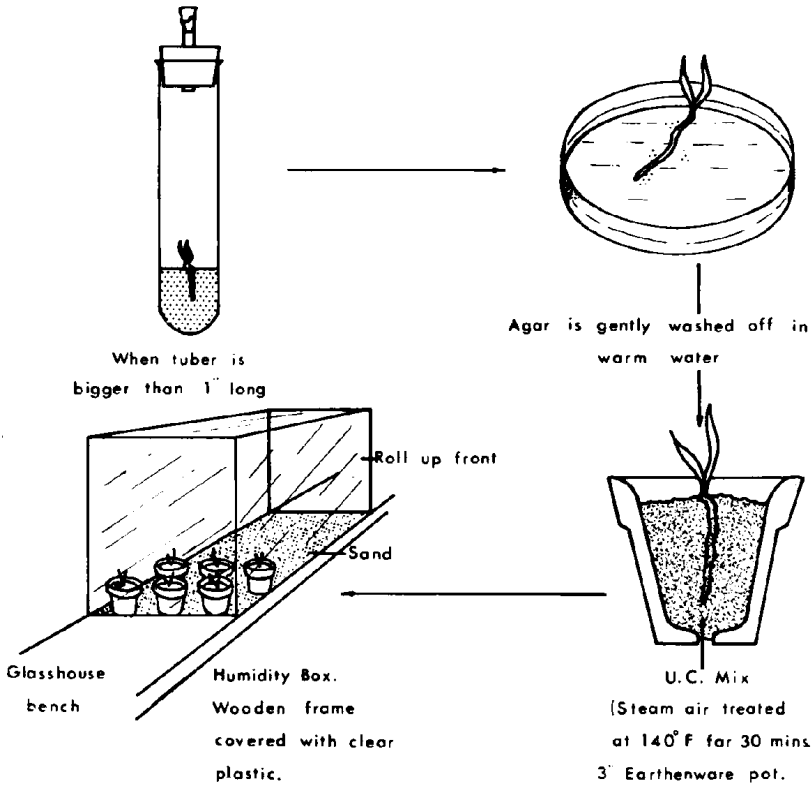


Fig. 2.—Transplanting seedlings into non-sterile conditions.

was plonted against a glass side in an earthenware pot so tuber growth could be observed. The glass was covered with black plastic. In the last two weeks oll plants were showing signs of going dormant—tops were becoming yellowish and some have already died off. The tubers appear to be quite healthy.

Originally it was thought the newly planted tubers would need a mycorrhizal fungus to enable them to grow. Several pots were watered with leachates from established pots of the same species, and other pots were watered with tap water as controls. After about one month there did not appear to be any difference in growth between the two groups. All pots are now watered with tap water.

It would appear if a mycorrhizal association does occur, the necessary fungi must be in the soil. No attempt has been made to confirm this at this stage.

29 different seed lots have germinated and reached the protocorm stage. Of these 6 have been planted into soil.

Seed sown in July and November 1970 did not perform as well as later seed because many tubes were allowed to dry out. This was due to cotton wool bungs being used instead of the breathing tubes (Fig. 1) also they were not transplanted as frequently as they should have been. In spite of this however most of these have reached the planting out stage or have been planted out.

Readers should not be dismayed about the complexity of growing terrestrials from seed. If you can successfully raise epiphytes then you should be able to grow terrestrials from seed. Laminar Flow cabinets, incubators, autoclaves, etc. only make the job a lot easier. It is certainly not beyond the keen amateur without these facilities. In fact it is doubted if many epiphytes would have survived the terrible things done in ignorance to our early terrestrials—they are pretty hardy at the early stages.

Species	Botanic* Gardens Numbers	Date Seed Sown	Dry seed Pod or Green Pod	Time taken (in months) From time seed is sown for: Seed to swell	Definite protocorm to form	Definite shoot to form	Definite tuber to form	Age in months of transplanting into soil	Size of tubers at transplanting into soil or 1.12.71	Length of time in months plants have been growing in soil at 1.12.71
Acianthus reniformis	711775	20-9-71	G.P.	1	2	–	–	–	–	–
Caladenia sp.	711750	5-7-70	D.S.	2	3	4-5	8-9	15	¾"-1"	2½
Calochilus robertsonii	711751	24-11-70	D.S.	4	5	8-9	11	–	⅛"	–
C..... robertsonii	711752	8-1-71	D.S.	4	6	8-9	10-11	–	¼"	–
Cryptostylis erecta	711778	22-2-71	G.P.	7	9	–	–	–	–	–
Diuris sp.	711753	5-7-70	D.S.	2	5	5	10	–	1½"	–
D..... sp.	711754	8-1-71	D.S.	2	3	4-5	–	–	–	–
Glossodia major	711755	21-9-71	D.S.	1	2	–	–	–	–	–
Pterostylis acuminata	711756	25-8-71	G.P.	3	4	–	–	–	–	–
P..... concinna	711757	29-7-71	G.P.	1-2	2	4	–	–	–	–
P..... curta	711758	8-1-71	D.S.	5	6	dead	–	–	–	–
P..... curta	711759	20-8-71	G.P.	1	2	–	–	–	–	–
P..... curta	711760	21-9-71	D.S.	1	2	–	–	–	–	–
P..... nutans	711761	29-7-71	G.P.	1-2	2	–	–	–	–	–
P..... obtusa	711776	6-4-71	G.P.	1	2	–	–	–	–	–
P..... parviflora	711777	6-4-71	G.P.	1	2	2-3	7	–	⅛"	–
P..... pedunculata	711762	20-8-71	G.P.	1	2	–	–	–	–	–
Thelymitra aristata	711763	5-7-70	D.S.	2	3	5	8-9	15	¾"-1"	2½
T..... aristata. *	711764	8-1-71	D.S.	2	3	3-4	5	8-9	½"-1¼"	3½
T..... carnea	711765	24-11-70	D.S.	2	3	5	8-9	–	¼"-½"	–
T..... carnea	711766	24-11-70	D.S.	2	3	4-5	8-9	–	⅜"	–
T..... carnea	711767	24-11-70	D.S.	2	3	4-5	8-9	–	¾"	–
T..... chasmogama	711768	5-7-70	D.S.	2	3	4	8	15	1"	2½
T..... nuda	711769	5-7-70	D.S.	2	3	4-5	8-9	15	1"	2½
T..... pauciflora	711770	24-11-70	D.S.	2	3	4-5	8-9	–	½"-⅝"	–
T..... pauciflora	711771	24-11-70	D.S.	2	3	4-5	8-9	–	¼"-½"	–
T..... pauciflora	711772	8-1-71	G.P.	2	3	4-5	8	–	¾"	–
T..... pauciflora	711773	20-9-71	G.P.	1	2	–	–	–	–	–
T..... sp.	711774	5-7-70	D.S.	2	3	5	9	15	1"	2½

ACKNOWLEDGEMENTS

Thanks are due to Miss Terri Woolcott for the drawings in this article. We also thank Mr. York Meredith of Dos Pueblos for helpful discussion and hints.

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The Germination of **Eriostemon australasius** pers. subsp. **australasius** (syn. **E. Lanceolatus** Gaertner F.) Without Fire

by D. K. McIntyre and G. J. Veitch, Canberra Botanic Gardens

Eriostemon australasius Pers. s.sp. *australasius* occurs on Hawkesbury sandstone, Central and North Coast of N.S.W., Stanthorpe and Wallum areas of Queensland (Wilson 1970). It is an erect bushy shrub 1-2 metres high with pink to mauve flowers (rarely white). This shrub has great horticultural potential but is difficult to propagate both from cuttings and seed.

In its natural habitat seedlings appear in profusion after o bushfire has been through an area. It is claimed that seeds do not germinate and seedlings do not appeor without fire. (This point has not been checked by the authors). It is a fact however that seedlings do not appear in any great numbers in non-fire periods. Seeds may germinate and the seedlings be hidden from view by other plants and litter, possibly never reaching any great size because of competition for water, space etc., small plants may also be destroyed by fire. Germination and growth may be inhibited by substances present in the soil as leachates from leaf litter.

Even though some of the above is speculation it is clear that a bushfire causes several things to occur; competition from surrounding species is removed; leaf litter is removed; some heat is applied to the seeds; and leachate from burnt material is washed through the soil after rain and this leochate comes in contact with buried seeds.

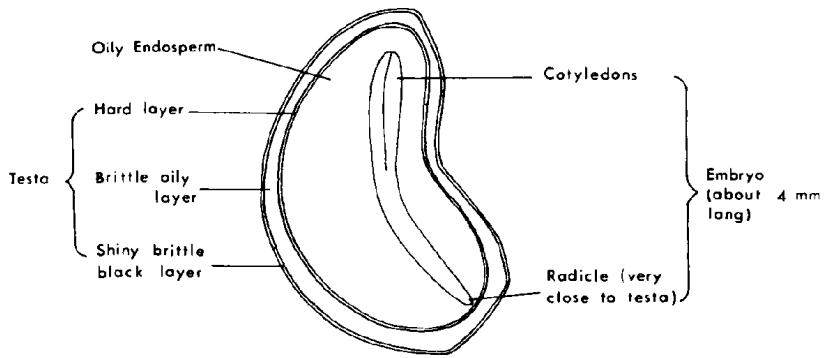


Figure 1—L.S. *Eriostemon australasius* seed

If a seed is held in a match flame for only one second, the heat is enough to kill it, because the radicle is very close to the seed coat and is easily damaged by heat. This suggests that seeds would be killed if they were on the surface of the soil in the path of a bushfire.

If the seeds were buried under the soil the temperature reached by the seeds during a bushfire would not be very high probably rarely over 100°C. Dry soil is a very poor conductor of heat and if it were moist, all the water would have to be distilled off before the temperature would rise

above 100°C. This would be unlikely to happen in the short period of time a bushfire takes to pass over a given point. It is therefore likely that if heat is involved, it is probably not a great amount and not for a very long period of time.

If *E. australasius* seeds are planted in the normal way, and kept moist and well attended, they will not germinate after 9 months—probably even longer. This is being tested at the moment.

Some success has been achieved by a few growers who have planted the seeds in a pot, lit a fire on top of it, and then watered it regularly. Sometimes it works and the seeds germinate, but there has been no precise recording of the method. The depth the seed were sown, the moisture content of the soil, the fuel used, and the time the seeds took to germinate after the burn, are all important factors in the repeatability of such a method.

A repeatable method for the germination of *E. australasius* seed without fire has been developed.

Several thousand seed were collected from the Sydney area just before they dropped from the plants in December 1970.

A viability test was carried out on a sample of about 150 seeds using 1% tetrazolium chloride. (International Rules for Seed Testing 1966). The embryos were extracted from the seed by carefully chipping the testa away at the radicle end, and soaking the seed for at least 24 hours in water. The embryos partially emerged and were easily dissected from the seeds. They were then soaked in the tetrazolium chloride solution for 24 hours in the dark. Living cells stain red and non living cells are unstained.

Only 25% of the seeds tested were considered to be viable, assuming that both the root tip zone and the shoot apex area had to be living for the embryo to be viable.

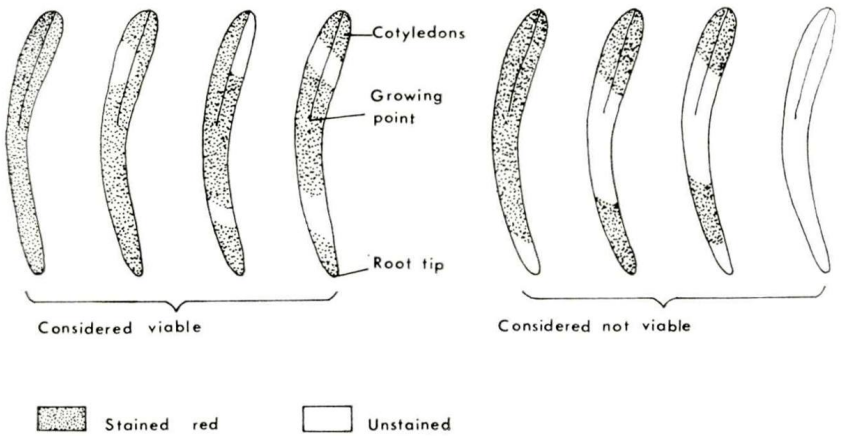


Figure 2.—Sample of stained embryos and how they were interpreted.

It was thought inhibitors may be present in the seed coat or the endosperm, preventing germination.

To test this the seed coats were carefully removed from 50 seeds and the endosperm plus embryos were surface sterilised with 0.5% sodium hypochlorite. These were placed on agar in sterile tubes. 50 embryos were extracted, surface sterilised and placed on agar in sterile tubes.

After about 3 weeks one of the embryos with the endosperm attached, began to grow, the remainder did not germinate. While this result was encouraging it was obviously not the answer for raising seedlings.

The second breakthrough occurred by accident. About 50 seeds which had been chipped and left submerged in tap water, were accidently left soaking for 2 weeks. Rather than throw them out the seeds were sown in a punnet. After about 3 weeks three seeds germinated.

On the basis of this result the following technique for germinating the seed has been developed. The seed coat is carefully chipped away from around the radicle end (large end) of the seed with a scalpel, exposing the endosperm being very careful not to damage the radicle.

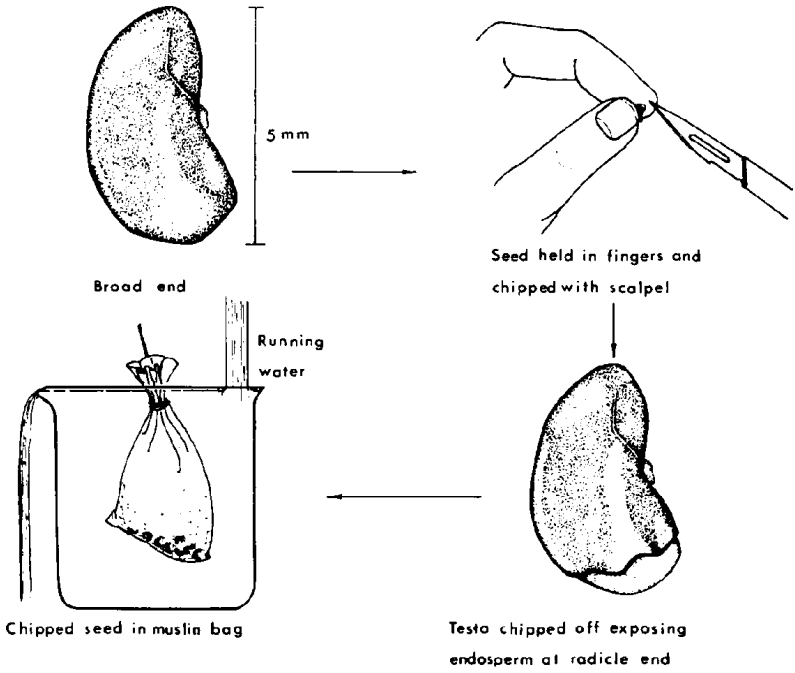


Figure 3.—Methods used for chipping and washing seed.

The chipped seeds are put in small muslin bags and placed in a stream of running water for 2 weeks. Running water is preferred to soaking, because it prevents a build up of fungal and bacterial growth and continuously removes any substances washed out of the seeds. The seeds are then planted in a punnet of sand/perlite and placed on a capillary bed. Germination usually takes about one week.

This process has been repeated several times, and in the last batch of 100 seeds, 29 germinated after one week in the punnet. If the viability results are used as a guide, then probably all viable seeds germinated. Germinated seeds were pricked off into 2" plastic tubes (Fig. 4).

Batches of seeds were sown which had been

(a) Chipped at the radicle end without washing.
(b) Washed for 2 weeks then chipped at the radicle end.
(c) Cracked in a vice and washed for 2 weeks.
(d) Chipped at the back of the seed only and washed for 2 weeks.

There was no germination in any of these treatments after 4 months. It appears therefore that both chipping the radicle end of the seed and the leaching process are necessary.

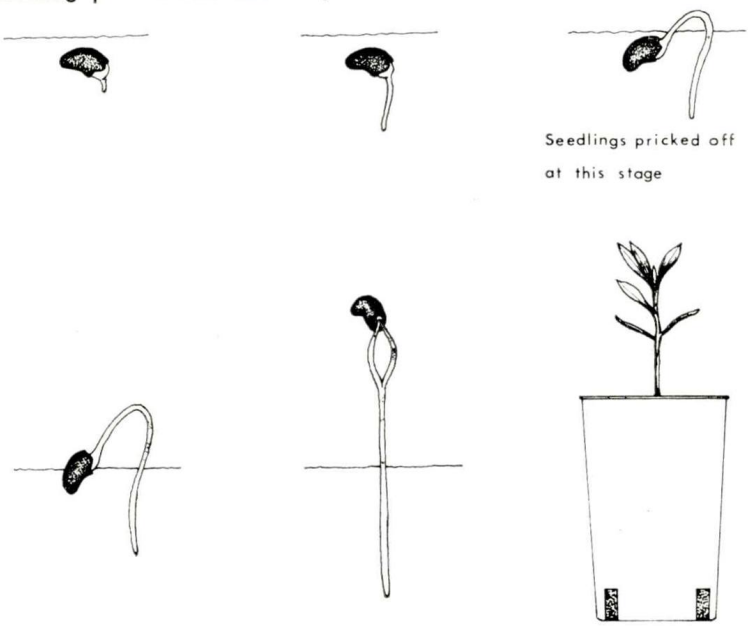


Figure 4.—Stages of germination and early seedling growth of *E. australasius*

These results raise several questions regarding the actual mechanisms operating in the field. What is the role of heat? Does heat crack the seed coat and allow water to penetrate to begin a leaching process? If this is the case why don't seeds germinate which are slightly damaged and then remain in the soil subjected to continual leaching? Does the action of heat have a biochemical role?

These and many other questions remain unanswered. The first and very important step however of germinating these seeds has been taken. Work is continuing to try and determine whether inhibitors are present and also the exact role of fire.

E. australasius is only one species in a large group in which the seeds will not germinate normally but do so after a bushfire. Many of these are in the Eastern Rutaceae and include Eriostemons, Boronias, Zierias and Phebaliums. This group contains many species of great horticultural potential. Some are difficult to grow from cuttings, so a method allowing them to be grown from seed is desirable. It is hoped that an understanding of the mechanisms involved in the dormancy of *E. australasius* seed, may lead to all species in the group being easily grown from seed.

ACKNOWLEDGEMENTS

Thanks are due to Miss Terri Woollcott for the illustrations in this article.

Thanks also to members of S.G.A.P. from the Sydney region who helped in the collection and supply of seed.

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II. RAISING NATIVES FROM SEED

PROPAGATION METHODS USED AT CANBERRA BOTANIC GARDENS.

A previous article dealt with the methods used at the Gardens for raising natives from cuttings. This article will deal with the raising of natives from seed.—D. K. McIntyre.

All seeds other than annuals (which will be the subject of a separate article) are germinated in the following way:- 5" x 3" x 2" deep plastic punnets are filled with a moist 50/50 mixture of perlite and washed river sand which has been sterilised at 140°F for 30 mins. The mixture is compressed firmly with a wooden block. This is important because the medium has to be packed firmly to permit capillary movement of water to prevent the seeds drying out. The seeds ore sown on the surface and covered with 2 to 3 times their depth with the sand/perlite mixture, which is pressed again lightly with the wooden block. (Fig. 1). If the seeds are very small e.g. *Callistemon*, then a layer of finely sieved mixture is placed just below the seed and pressed firmly down, to prevent the seed falling too deeply down in the punnet. These fine seed are barely covered with a very light finely sieved mixture.

The punnets are then placed on capillary beds (Fig. 1). These beds, developed at Parks and Gardens Research Section (Setchell 1967), are housed in a propagation room, which has double brick walls and an insulated ceiling. Air movement in this room is controlled by two 3 speed exhaust fans in the ceiling and 4 shuttered ventilators in the walls. The air temperature, thermostatically controlled, is maintained at a minimum of 70°F by 4 infra red strip heaters on the walls. In the summer the maximum air temperature is kept between 70-80°F by an evaporative cooler, which is thermostatically controlled.

One 400 watt Mercury Vapour horticultural lamp is mounted over the centre of each bed, 28" above it.

The light is only necessary for seedling growth after germination, and at the moment a 10 hour day is used, and this is controlled by a time clock. It is hoped to replace these Mercury Vapour lamps with banks of fluorescent lights shortly as the light distribution from the MV lamp is not uniform enough and some seedlings at the edges of the beds tend to bend quite considerably towards the centre.

Each bed is 2'4" wide, and 5' long and 3" deep, and holds approx. 100 punnets. Water is distributed evenly to all parts of the tray by three ½" copper pipes with ⅛" dia holes every 9". These are covered with pieces of crock or plastic to prevent them clogging up and the tray is filled with coarse washed river gravel (about ¼" dia). The water level is maintained in the tray by adjusting the ball in the cistern. This level is usually maintained at about 1" above the bottom of the tray.

The punnets are placed about ¾" into the bed and the gravel is pressed around the sides. The water rises up to the surface ensuring that the seeds will always be moist and well aerated, but never over watered. Experience will tell how far to put the punnets into the bed, and what level to have the water in the bed (both can be varied of course). Care must be taken to ensure capillary is established when the punnets are placed on the bed, and also once the capillary is established care must be taken not to break it.

The seedlings are pricked off at the cotyledon stage or very soon afterwards, into 3" earthenware pots or 2" plastic tubes filled with UC mix

(as described for cuttings). The 2" plastic tubes are favoured because they take up less space than the 3" pots and require less watering, because they do not lose water from their surfaces like earthenware pots.

This method of seed germination has proved very successful over a very wide range of seeds, and has many advantages. The seeds do not require watering or any attention from the time they are sown till they are pricked off. Germination is good and there is virtually no loss due to damping off and other diseases. The consistency of the sand perlite mixture makes pricking off eosy, as it does not require much effort to break it up and thus lessens root damage.

It is hoped to be able to heat one of the three capillary beds with floor heat cable under the tray to raise the water temperature, which will increase germination rates, particularly in the winter.

Seedlings in 3" pots and plastic tubes are placed in cold frames, transplanted into plastic bags and moved to sub-irrigation bays (as described for cuttings in the previous article).

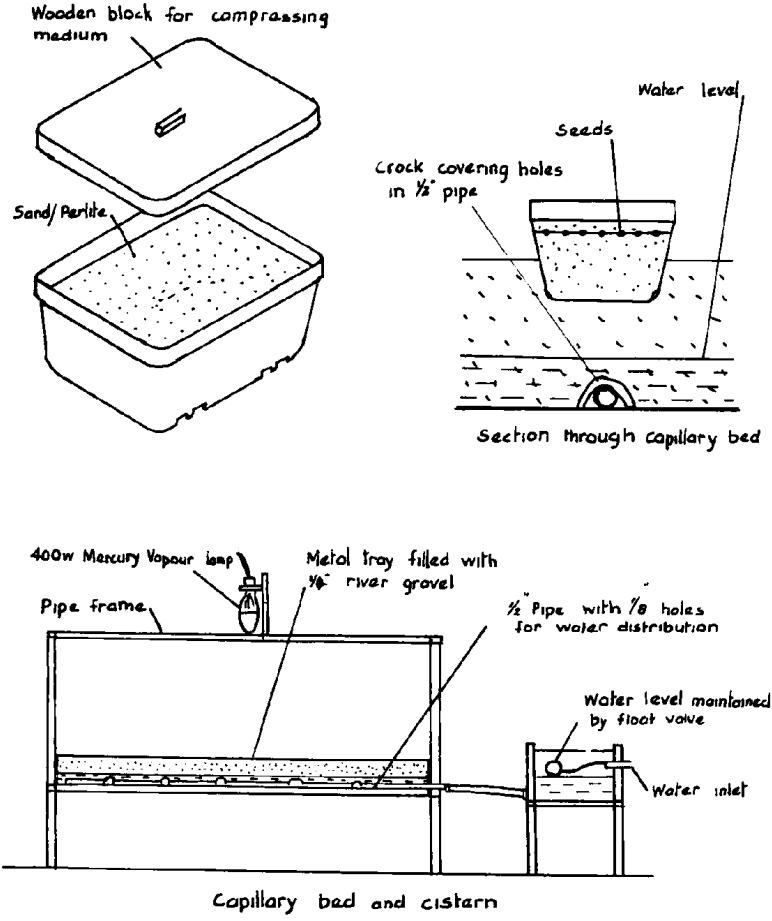
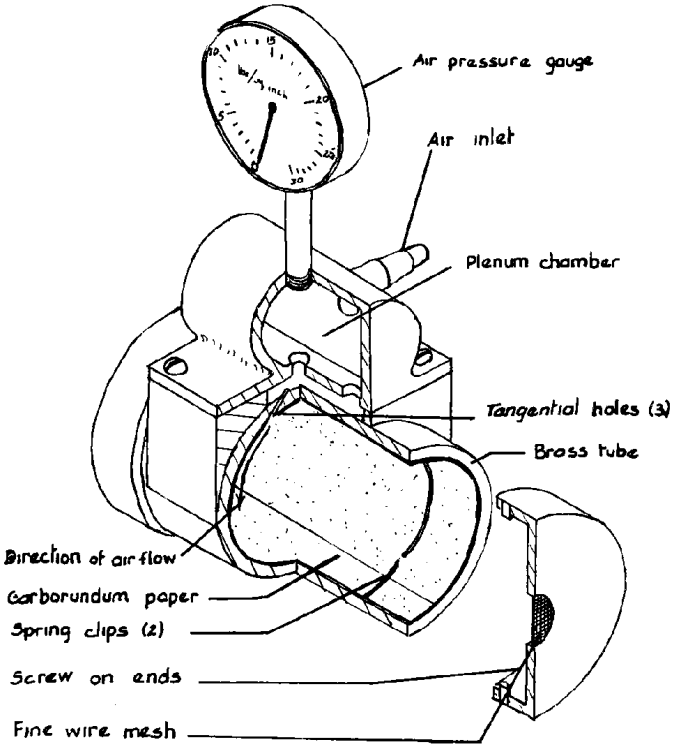


Fig. 1—Capillary bed and seed sowing technique

Seed Scarification

Many seeds (particularly Acacias and those in the family Papilionaceae) have a physical dormancy, which simply means they have a seed coat which is impermeable to water, hence they cannot take up water to commence the germination process. Many methods have been employed to break this dormancy such as pricking or nicking each seed, rubbing the seed between two sheets of sand paper, soaking in sulphuric acid and pouring boiling water over the seeds. All of these procedures produce the same result i.e. they break the seed coat and allow water to enter the seed. Even though these methods have proved reasonably successful with many species, a method which gives more reliable results has been developed using a seed scarifier.

The scarifier is similar to that designed and developed by C.S.I.R.O. Plant Industry (Ballard 1967) for scarifying clover seeds (Fig. 2).



The seeds are placed in the chamber and they are rotated by the compressed air against the emery paper lining the chamber. This abrades the seed coat and allows water to penetrate.

This machine is extremely efficient and the conditions are repeatable, i.e. once a suitable treatment is found for a particular seed, this can be reproduced at a later date.

There are four things which can be varied.

(a) Air pressure—for light seeds the pressure used is normally about 10 lbs./sq. inch (psi), for larger seeds the pressure can be increased up to 25 psi.

(b) Grade of emery paper—for nearly all purposes a fairly fine 240 grade paper is used. It has been found that coarser paper tends to cause damage to the seeds.

(c) Number of seeds—more small seeds can be scarified at the one time than large seeds.

(d) Amount of time the seeds are scarified—e.g. *Clianthus formosus* seed required 2 mins. at 11 psi with 240 paper while some Acacias required 25 psi for 15 minutes.

The method used to determine the amount of scarification necessary is to scarify the seed for a couple of minutes at, say, 10 psi and see how much abrasion has occurred on the seeds. An estimate is then made for further scarification. When a considerable amount of abrasion has occurred, but not enough to damage cotyledons or embryo, the seeds are soaked in hot water. If the treatment is sufficient they will begin to swell within a few minutes. If they do not swell within ½ hour they are dried and rescarified and the process is repeated. By using this method on a large number of seeds experience is gained at estimating the correct amount of pressure and time etc.

The following table compares the germination rates and percentage germination of several seed lots which were given boiling water treatment which consisted of pouring boiling water over seeds and allowing the water to cool, and with seed which were scarified.

Species	Treatment	Percentage germinated after 7 days
Clianthus formosus	Control	8
	Boiling water	7
	Scarified	95
Lotus australis	Control	34
	Boiling water	26
	Scarified	96
Lotus corniculatus	Control	10
	Boiling water	14
	Scarified	96
Hovea lanceolata	Control	0
	Boiling water	12
	Scarified	80

This method has speeded up germination rates and increased percentage germination in Acacias and Papilionaceae. It is important in ensuring a quicker turnover of space on capillary beds and allows more species to be sown in a shorter time. The scarifier is very useful for dealing with small numbers of seeds, but for larger amounts of seed, a larger scarifier may be necessary.

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A Low Maintenance Low Cost Method of Propagating Cuttings

by Heather Meek, Canberra A.C.T.

Over one year of experiments with propagating native plants I have developed a method for propagating cuttings. My system is primitive but most importantly it demands very little attention, and has produced good results.

The system evolved out of an attempt to provide a suitable wind protected spot for propagating natives on a steeply sloping block facing west and almost at the top of a steep hill. Being forced to provide a wind barrier to prevent instant drying out, a wooden structure was made to give eight feet in height for head room and a clear space approx. nine feet by six feet underneath it for containers, traffic way and work bench. This structure has vertical walls on three sides, the fourth side being angled at about 45 degrees from ground level up to a small flat roof nine feet by three feet. It was covered with corrugated translucent plastic sheeting. The covered frame was then positioned on an asphalt surface at the end of an open ended carport which protects it overhead and from the east, west and south. The sloping side faces north. A door was hung at one end for access and a ventilation flap of carpet was attached above the door.

From mid October to mid April the sloping north facing wall was covered with 64% shade cloth. Temperatures (measured with a max.-min. thermometer) have ranged from 34°F to 94°F.

An area of the floor approximately four feet by four feet was covered with about an inch of finely crushed river gravel and the cutting pots were positioned in this. An upturned slightly tilted plastic pot with a 3" concave base was placed at the edge of the area and a hose was positioned about 6' above it. Water was allowed to drip onto the pot, the concave surface acting as a drip spreader. The tap was adjusted so that it dripped once every 2-4 seconds (slower in winter and faster in summer).

It is surprising to find that the drips are dispersed as a fine spray over an area of about 9 square feet, wettest close to the source and drier at the edges. A convex surface does not disperse the drops as well. It is important that the concave surface be tilted, otherwise the drops build up a pool which does not disperse the water on impact. The hose has to be at least 5' above the pot to give good dispersion of the drip.

Preparation of cuttings was standard, but included soaking for half an hour in a pale pink solution of potassium permanganate. The pots were layered from the bottom up with very coarse sand for drainage, then well rotted grass, coarse sand to within one inch of the top of the pot, and finally half an inch of vermiculite.

The first cuttings to be attempted were from a *Boronia megastigma* which had been damaged at the end of its flowering in October, 1970. Thirty-six cuttings were prepared including material that was considered unsuitable. The first were potted up the following February, with good root systems and others have rooted up to the present—14 months later. Three cuttings are still alive and healthy without roots. They indicate the ability of the system to keep cutting material alive and fresh through all seasons and weather, without the aid of artificial heat above or below the cuttings.

The following is a list of species struck from cuttings so far and the percentage of strike where availablie.

Astartea fascicularis 25%, *Brachysema lanceolatum* 100%, *Baeckea asteoides*, *B. linifolia*, *Bauera sessiliflora* 90%, *Boronia megastigma*, *B. flilifolia*, *Calytrix tetragona* 100%, *C. sullivanii* 100%, *Crowea exalata* 100%, *Chamaelaucium uncinatum* (pink) 40%, *Correa "Mannii"*, *Eremophila glabra* 100%, *E. maculata* (red upright), *Frankenia pauciflora* 100%, *Hibbertia dentata*, *Kunzea ambigua* 100%, *Kennedia prostrata* 100%, *K. glabrata* 80%, *K. eximia*, *Grevillea victoriae* (form from ranges near Canberra), *G. victoriae* (nursery hybrid form), *G. thelemanniana* (prostrate bright green foliaged form) 100%, *G. lavandulacea* (Black Range form), *G. juniperina* (prostrate pink form) "Pink Lady", *Lechenaultia biloba*, *Micromyrtus ciliata*, *Myoporum parvifolium* 100%, *Melaleuca incana* 100%, *M. armillaris*, *M. steedmannii*, *M. "Payne's hybrid"*, *M. diosmifolia* 100%, *M. seriata*, *Olearia ramosissima* 100%, *Podocarpus lawrencei*, *Platysace lanceolata*, *Phebalium ozothamnoides*, *Pimelea ferruginea*, *Prostanthera ovalifolia* (long leaf form) 100%, *P. ovalifolia* (round leaf form) 100%, *P. incana* 100%, *P. saxicola* var. *montana* 100%, *P. cuneata*, *Regelia ciliata*, *Scaevola hookeri* 100%, *S. aemula* 100%, *Tieghemopanax sambucifolius*, *Thryptomene saxicola* "Payne's variety" 100%, *Parahebe perfoliata*, *Veronica formosa*, *Westringia glabra*.

The cuttings were checked for roots about every two months. If roots were visible the rooted cuttings were carefully separated and potted up into a standard potting mix that was damp enough to hold together if a handful was squeezed but not so damp that it prevents sprinkling around the roots. The plant was then gently watered in from above and topped up with mix if it subsided.

The newly potted plants were kept in the plastic house along the southern wall for a week or more then transferred to my sub-irrigation bays which are in full sunlight all day, but covered with 60% shade cloth.

The sub-irrigation bays are simply sheets of black plastic supported by a rectangle of cement bricks, with about 1" of finely crushed river gravel in the bottom. The bags and pots are placed onto this gravel. The bays are filled with water to approx. 2/3rds the height of the pots, after about 20 minutes the bay is drained by removing a brick. The gravel allows the water to drain away well and prevents the pots from standing in water.

With this system I have produced in excess of 400 plants in a year.

As a newcomer to native plants (in fact to gardening of any description), I can not resist writing of these experiments particularly for other newcomers. It has been fun, exciting, and satisfying to propagate native plants. These new plants have replaced those dead in the garden, built up clumps of small ground cover plants, produced beds of annuals, helped stock the S.G.A.P. sale table, and on a broader scale contributed to the survival of species that are threatened in their own environment.

My system particularly as used for rooting cuttings requires remarkably little time or effort, and produces large numbers of plants. The cost of building the structure was around $35 while the cost of maintaining it is nil. The effort once the cuttings have been collected, prepared and positioned is only that of removing any dead material every couple of weeks, and checking that the hose is still dripping—yaur ears tell you this from about 15 ft. away.

Many growers of native plants shy away from propagating, considering it too difficult—I would like to explode this myth, as often I have found it is far easier to produce a rooted cutting or a seedling than to raise them to maturity.

PESTS OF NATIVE PLANTS IN THE CANBERRA REGION

by W. A. MARTIN in Canberra

In the A.C.T. much of the newly developed residential areas were savanna woodland which had previously been cleared and used for grazing for many years with the result that large areas are bare of trees. Great effort is made by N.C.D.C., and the Dept. of the Interior, to save the few remaining Eucalypts. People planting native trees and shrubs, particularly if they wish to attract birds into their gardens by providing tall trees for food and protection, choose Eucalypts as being most suitable for that purpose.

The naturally occurring Eucalypt forests in the surrounding mountain ranges and the Eucalypts in the remainder of the savannah woodlands are frequently severely attacked by numerous pests, thus the resulting heavy infestation of pests on the succulent growth of young gum trees in gardens is to be expected.

Chemical control of pests becomes necessary for best growth of trees. This places the keen gardener and bird lover in a dilemma; knowing that by controlling pests to encourage growth of trees to bring birds into the garden they may actually be doing some damage to bird life. However it does appear that birds are not common in a new garden for 3 or 4 years, by which time most Eucalypts are of such a size that spraying is not essential.

The very act of introducing a plant into one's garden may result in that plant being attacked by insects which do not occur in the plant's natural habitat. It is also possible to introduce a pest from a nursery or from cuttings collected in the field without also introducing its natural predator and parasites. A classical example of this was the introduction of Eucalyptus scale into New Zealand with Eucalyptus trees, the scale reaching devastating proportions until one natural predator, a small ladybird beetle, was also introduced from Australia.

Many people do not like to use insecticides for one reason or another and it is frequently not necessary to use chemicals for control of pests. Manual control by physically removing pests, before they build up into plague proportions is better than later chemical control. However frequent inspections are necessary as many pests rapidly build up in numbers.

Many of the pests mentioned below can be controlled by simple physical means. Eucalyptus scale can be scrubbed off with an old toothbrush dipped in dilute white oil, or on larger trees when scale is young a strong jet of water from a hose will wash scale off trees. Gall forming insects are easily removed by stripping infested leaves off the tree. Some chewing insects particularly beetles and their larva, are also easily removed. When handling insects, gloves should always be worn, as many insects exude irritating chemicals.

Eucalyptus Pests:

Psyllids: These are small sap sucking insects, most species of which live under a scale-like cover called a lerp. This cover is frequently ornamental, some having the appearance of a shell. One species living amongst the flower buds of *E. polyanthemos* has a lerp that is similar to the operculum of buds. Another free living species without a lerp severely attacks the young shoots and leaf buds of *E. bicostata*; yet another, with a woolly sugary lerp is common on *E. cinerea*, providing winter feed for honeyeaters.

Most psyllids are very seasonal in nature and usually no control is necessary. The two psyllid species attacking *E. blakelyi* and *E. melliodora* can cause partial or complete defoliation. The masses of lerps on the leaves

give them the appearance of being covered with snowflakes. The natural predators, pardalotes and a parasite wasp, usually keep this pest below plague proportions. However every two or three years a build up occurs due to the failure of the parasite wasps to breed and control measures may be necessary. A systemic chemical is necessary for control, dimethoate being used usually as a foliage spray, but a trunk injection system can be used; ⅜" diameter holes are drilled 1-2" deep about 4" apart around the tree trunk and about 1 cc of neat dimethoate is placed in each of these holes and the holes carefully pugged. The stem injection is not very successful with mature trees, but is worth trying.

Sawfly: The larva of Sawfly wasps *(Perga spp.)* are usually large, black and caterpillar-like. Commonly called "spitfire", they are usually seen in large clusters in spring and summer. They adopt an a aggressive pose when disturbed, waving their "tails" in the air. They can quickly defoliate trees, having few natural predators. Control is best achieved by removing the clusters by hand or by spraying with carbaryl.

Eucalyptus Scale: A very common pest, usually first noticed when "honey-dew" from scale drops onto lower leaves and is infested with sooty mould. Occurs as a cluster of round white egg-like scales around smaller twigs and rarely along main vein of large leaves. Three or more generations a year occur, each female giving birth to about 400 crawlers which move rapidly around the tree for 1-2 weeks before settling in clusters. Natural predators such as a moth larva, a ladybird and a fly larva occur giving good scale control on old trees, but on young trees chemical spraying may be necessary. Two to three applications, about 2 weeks apart, of superior summer oil in October-November give reasonable control, particularly if applied when crawlers are emerging. For persistent scale it may be necessary to add dimethoate or maldison to the superior summer oil.

Eucalyptus Leaf Eating Pests: Either or both the adult larval stage of numerous beetles cause considerable defoliation. The weevil-like snout beetle *(Gonipterus scutellatus)* and its larva are common defoliators in the spring as are the Eucalyptus Tortoise beetle *(Paropsis atomaria)* and related beetles. Christmas beetles particularly cause severe defoliation over 3-4 years and some moth larva cause partial defoliation. Spraying with maldison or carbaryl will control these pests.

Mistletoe Moth: Mistletoe on *Eucalyptus blakelyi, E. melliodora* and *Casuarina cunninghamiana* is frequently defoliated by the larva of the mistletoe brawn tailed moth *(Euproctis edwardsii).* When pupating the larva sheds large amounts of stinging hairs which are extremely irritating to the skin. Control is best achieved by removal of the mistletoe from trees or by spraying with carbaryl.

Gall forming insects at times cause considerable distortion to Eucalyptus leaves particularly to *E. mannifera ssp. maculosa* and *E. pauciflora.* Control is difficult as the insects causing the damage are well protected by the gall. A possible control is the use of dimethoate when young foliage is present as all galls appear initially on young leaves.

Callitris Pests: In this region some Callitris species are becoming increasing-ly defoliated by Sawfly larva, the larva being about 1" long, green coloured and transparent looking with a rounded abdomen. This pest is hard to see in trees but can quickly defoliate Callitris and is causing damage to the exotic Golden Cypress *(Cupressus brunniana).* A spray of carbaryl will give control.

Callistemon Pests: The three main pests of Callistemon are a scale insect, a sawfly larva and a thrip. The scale insect causes considerable disfiguration of the leaves, forming gall-like swellings; the thrip causes leaf edges to roll in, under which shelter it lives; the sawfly larva, a large attractive caterpillar-like larva with a sword-like appendage on the abdomen, can completely defoliate some species.

The scale and thrip are controlled by an application of white oil and dimethoate, sawfly larva by carbaryl.

Melaleuca Pests: Few pests are seen on Melaleucas, the only one requiring chemical control being a scale on M. *incana*. This scale is similar to that of Eucalyptus, control being the use of white oil.

In the Braidwood area complete and annual defoliation of a naturally occurring Melaleuca sp. is being caused by a sawfly larva. However this has not yet been seen in Canberra.

Acacias: Possibly Acacias have more pests than Eucalypts but only a few cause enough damage to justify chemical control.

The major pest is the Acacia bug *(Eucerocorpis tumidiceps)* a sap sucking insect which does considerable damage to many phyllode type Acacias. The damage to some species consists of circular black spots on the leaves, on other species rust coloured irregular shaped areas between the veins. These insects are hard to find and do not occur in great numbers. Damage can be severe, damaged areas eventually covering the whole of the phyllodes, which then drop off. Control is achieved by use of a systematic spray such as dimethoate, but it may be better to remove heavily damaged acacias, as spraying will be necessary two or three times a year.

Numerous leaf rolling and webbing moths occur, but spraying is not usually necessary. Some species are heavily attacked by boring beetles, some degree of control being achieved by regular inspection of trunk for holes, clearing away loose bark and applying persistent chemicals such as lindane to the trunk with a paint brush. Diluted dimethoate or lindane can be squirted into uncovered borer holes by means of an oil can.

There are more insects attacking native plants than mentioned in this article. If control is considered necessary, scale insects can be controlled with 2 or 3 applications of superior white oil when young scale is present; sucking insects require the use of a systemic spray such as dimethoate; chewing insects require an insecticide such a carbaryl or maldison.

Seed Collecting: When collecting seed one frequently finds year after year that seed weevils and moth larva have destroyed seed. Much of this damage can be prevented by an application of dimethoate shortly after flowering. Some species may need 3 or 4 applications at 10-14 day intervals to control weevils, or if seed is being collected from an area visited infrequently, an application of the more persistent chemical lindane about a week after flowering may be better.

Spreader: The use of a commercial surfactant or wetting agent is considered essential for best results, particularly if spraying Eucalypts. However if an oil spray is being used the wetting agent can be omitted.

The controls recommended in this article are those which give a reasonable pest control with as little harm to beneficial insects as possible. There are far more effective pesticides available, but their use is to be avoided. The pesticides mentioned, with the exception of lindane are of relatively low toxicity to humans and are of short residual life. However dimethoate is extremely toxic to birds and bees. It should not be used where birds roost or feed. No chemical should be used when plants are flowering.

CALANDRINIA

by J. H. WEBB, Canberra

A genus of plants belonging to the Portulacaceae family and represented by about 150 species in both North and South America and Australia.

About 30 species are endemic here mostly in arid areas and at least one species is found in every state, they are all non woody herbs with many species being succulents.



CALANDRINIA BALONENSIS

Calandrinia is perhaps better known in Australia by its common name of "Parakeelya", its succulent leaves in good seasons enable cattle and sheep in inland arid areas to graze without need of additional surface water. At the onset of drought conditions, other annual plants have withered and died before the parakeelya succumb. At least three of the larger flowered species show excellent adaptation to cultivation; *Calandrinia polyandra, C. remota, C. balonensis*. The last two have survived under outdoor conditions during a Canberra Winter.

CALANDRINIA—*cont.*

The circumstances of the cultivation of the latter species are worth relating as they illustrate the hardiness of the Genera. In the month of October a collection of plants including a specimen of a narrow leaved form of C. *balonensis* was made in the Northern Territory. Two weeks later the pressed specimen (between absorbent paper sheets in a plant press), arrived in Canberra; the specimen was no longer turgid but was still green and obviously alive. A stem transferred to a rooting medium of perlite and peat quickly recovered and rooted in a few weeks, a week later the new plant started to flower, and continued throughout the rest of the Summer. When planted out at the top of a stone retaining wall for a warm position with good drainage the plant bloomed until the Autumn. During the Winters of 1970 and 1971 when record low temperatures were experienced, the leaves progressively burnt back till only the stems remained and these being less succulent than the leaves survived until late Spring when the plant resumed growth and flowered a few weeks after growth started.

Other plants of C. *balonensis* were grown in pots in a light friable mixture and from a plant in a four inch pot over a hundred blooms were produced. These plants survived well indoors over the dormant Winter period by withholding water completely, for as long as two months. At the first sign of puckering of the leaves sufficient water was given to restore turgidity and then withheld again. With the coming of warmer weather the plants were regularly watered and soon resumed normal growth. Seed of C. *remota,* collected Simpson Desert, N.T., germinated well in sand and seedlings were very rapid in growth, and transplanted well without setback.

Under cultivation only one difficulty is experienced with *Calandrinia* and that is the tendency of the plants to over-extend themselves and with little secondary stem thickening the plant develops branches that break when growing over pot sides, or branches on the ground, soon overbalance and break away unless very sheltered.

Colours of flowers are purple and magenta, although white forms are known to occur. Flower size is up to one inch in diameter, but appears to be variable.

No pests or diseases have been noticed in cultivation in Canberra, but for more humid climates, rotting and mildews could be a problem.

A New Transplant Method of Eucalyptus

by J. H. WEBB, Canberra

The method of transplanting described, was originally developed and described by the author for use in Bonsai techniques for Australian natives, *Bonsai Journal of Australia,* Vol. 1, No. 4, Aug. 1969. However the method also has great application for native plant growers where the number of Eucalypts required is generally only one or two of a single species.

The method is not applicable to all species of Eucalyptus, as the prime requirement is the ability of the species to develop a "lignotuber" (Kerr, 1925) (Jacobs, 1955). As some 95% or more of all Eucalypts develop lignotubers under certain conditions, and the remaining 5% are mostly forest type trees not likely to be in demand for native plant growers, this does not severely limit its application.

First find a suppressed specimen of the required Eucalypt; this suppression could have been caused by trampling, mowing, grazing, shading, competition,

dryness, unfavourable site, or being pot bound. The seedling or tree is dug in Summer (January, February) under the driest hottest conditions possible and all roots no matter how thick cut off at the lignotuber. The stem or stems are also cut off about 3"-4" above the tuber, making sure no leaves are left on. Stem and root scars are sealed with grafting wax (colgraft) or similar and the tuber then potted to a depth of 2/3rds of the tuber in a porous, acidic reaction, water retentive mixture, e.g. (sand, peat) in a 4"-6" pot and kept moist. After 3 or 4 weeks shoots will appear on the top of the lignotuber and at the same time root tips break from the buried portion.

The number of top shoots will have to be thinned initially to four or five and eventually to one. The size of the tuber is not critical, the ratio of tuber diameter to stem diameter or sum of stem diameters is important and should be as wide as possible—4 to 1 ratio gives excellent results.

The tuber consists of large numbers of dormant epicormic shoots together with large stores of food reserves. These reserves are intact when the tree is not growing i.e. dormant and as mentioned this is in late Summer, before Autumn growth recommences. The exceptions are trees from cold areas which can be taken in Winter with a good percentage of success. A good guide is if the trees in the area produce regular visible annular growth rings, e.g. *E. pauciflora, E. camphora,* the initiation of growth here will be helped by bottom heat to break the tuber into growth. In the dry situation the application of regular water appears to break the tuber into growth.

The percentage of success is over 95% taken in Summer, dropping to 35% for other times of the year, the exception being the cold climate Winter dormancy where the percentage rises to 95% again—division of lignotubers lowers the percentage strike and is not recommended.

No difficulties are found in transport, tubers placed in plastic bags and kept cool have rooted well after transportation from Interstate occupying three or four days.

This method is not intended to replace normal propagation methods, but can be valuable especially when travelling, to be able to obtain a specimen of a Eucalyptus species where for a number of reasons seed is unobtainable.

Current experimentation shows that the same principles can be applied to other genera, these include *Tristania, Angophora, Melaleuca.*

A few of the species that DO NOT produce lignotubers are listed below with the thought that it may save some fruitless searching: *E. pilularis, E. grandis, E. seeana, E. camaldulensis* (southern form), *E. fraxinoides, E. fastigata, E. delegatensis, E. regnans, E. diversicolor, E. gomphocephala, E. nitens, E. astringens.*

Fortunately practically all of the smaller ornamental species suitable for gardens do have lignotubers.

REFERENCES TO LITERATURE

Kerr, L. R. 1925—The Lignotubers of Eucalypt Seedlings. Proc. Roy. Soc. Vic., XXXVII (1) 79-97.

Jacobs, M. R. 1955—Growth Habits of the Eucalypts, Forestry & Timber Bureau. Comm. Govt. Printer. 17-20.

FERN SPORE BANK

We are very conscious that nothing has been presented on Australian Ferns in this publication. At last we have engaged a professional botanist to review the fern families in a series of articles to commence shortly. Associated with this will be notes on cultivation. We have also established a fern spore bank and those interested to receive spore, and we hope, to contribute spore to the bank, may contact Mr. Stephen Clemesha, 18 Wesson Road, West Pennant Hills, N.S.W. 2120. If sending spore, wrap different species separately and if you do not know the correct name, insert a note about what you do know of the fern.

Spore is available of *Adiatum* 3 species, *Cheilanthes, Cyathea* 2 sp., *Cyclosorus, Davallia Dicksonia, Drynaria, Doodia* 3 sp. *Grammitis, Histiopteris, Lastreopsis Platycerium* 3 sp., *Polystichum* 3 sp., *Pellaea* 2 sp., *Pyrrosia, Microsorium* 2 sp., *Lindsaea* 2 sp., *Athyrium* 2 sp., *Asplenium* 4 sp., *Blechnum* 7 sp.

NATIVE GROUND COVERS—continued from page 247

Melaleuca pulchella, M. scabra, M. violacea.

These three W.A. mauve flowered Melaleucas have forms which are low spreading shrubs to about 3 ft. with a 5 to 6 feet spread. All require plenty of water although good drainage is an advantage. They flower in late Spring and early Summer and appear to be pest free. All are frost hardy at the Botanic Gardens.

Propagation is either from seed or cuttings but to preserve the required form, vegetative methods are desirable.

(D) SMALL AREAS IN ROCKERY POCKETS

or small areas between shrubs or between driveway strips.

Scaevola albida. All Scaevolas are useful rockery plants and many are dense enough to be classed as ground covers. *S. albida* in either white or blue colour forms is a close mat which may spread to 3 or 4 feet and remains mostly prostrate.

They grow readily from cuttings and require ample moisture and good drainage. Full sun or semi-shade locations are satisfactory and the species is frost hardy.

Propagate from cuttings, no pests noted.

Ajuga australis. Our plants were collected in South Australia and have done well in full sun and exposed to frosts. The purplish, blue flowers are borne on upright stems in Spring and Summer and in 2 years the plants have spread to about 2 feet in diameter.

The plant may be propagated from cuttings or root division and appeors to be pest free.

Clianthus formosus. Better known as Sturt's Desert Pea, it requires dry, well drained conditions and although frost tender is worth growing as an annual in cold areas. Plant early for best results. If scarified seed is sown in July in cold climates, plants may be nurtured in large pots (8") in cold frames until the heavy frosts have passed, say early September. The advanced plants are then planted in the open garden and covered for the first two weeks. Flowering should start almost immediately. Liberal application of a well balanced fertiliser at planting time is an advantage. Care should be taken not to overwater and drainage must be excellent.

Snails should be guarded against by using baits.

Spacing for mass planting should be no more than 3 feet.

Pelargonium rodneyanum. One of the best of the Australian Pelargoniums, this species hails from the Grampians in Victoria. It is readily propagated from cuttings and enjoys full sun. It spreads slowly and as a ground cover it should be planted at 18" centres. On trial now for 2 years in Canberra it is frost hardy and flowers for a long period over the warmer months.

Moderate watering is required. No pests noted.

Brachycome graminea. This is a plant of the east coast swomplands which is excellent for a damp location. It covers rapidly and may be propagated best by root division. Plants at Canberra are frost hardy and flowers are borne through the warmer months until late Autumn. The little daisy flowers are white or pale blue and no pests have been recorded.

Plenty of water is required for good growth and small plantlets should be placed at 12" for quick coverage.

Triodia irritans. Despised by many and rarely used in cultivation, the Australian spinifex is suggested as a ground cover for arid conditions or as a rockery novelty. It grows eosily from seed and forms a rounded

clump some 2 feet in diameter. Although it grows in low rainfall areas it thrives on the kinder conditions of cultivation.

It appears to be frost hardy.

Pultenaea capitata. Native to the Lake King area of W.A. the plant makes a superb mat 2 feet or more across with large heads of orange-brown pea flowers.



SCLERANTHUS BIFLORUS—*Scleranthus*—after two Greek words meaning "hard" and "flower" alluding to the hardened fruiting calyx. *biflorus*—two flowers. Blocks by courtesy of Canberra Botanic Gardens.

Scleranthus biflorus

This common plant of the N.S.W. high country has been grown in Canberra for a number of years and is slowly becoming wider known in cultivation elsewhere. The species forms a tight mat with the appearance of a moss, and is of tremendous value for rockery landscaping. If planted in a sunny but, damp situation the plants will shape themselves in and around rocks very quickly, to give a soft, green background to their more colourful neighbours. Belonging to the family *Caryophyllaceae*, the minute green flowers which appear in late Spring are insignificant. Propagation is either from seed or by root division and to give an idea of growth rate, a seedling will occupy about one square foot when 12 months old under average conditions in Canberra.

The Genus **Phymatocarpus**

Observations by D. Verdon, Canberra Botanic Gardens

Distribution:

This small genus comprises just two known species both occurring in the South West Province of Western Australia, and one found also in the southern part of the Eremean Province. Little has been written about the genus or its distribution and collections do not appear to be extensive. For complete study of distribution and habitat it is necessary to collect or view as wide a range of specimens as possible. Within the scope of this article, only a brief mention of known locations is undertaken.

The original collection of *P. porphyrocephalus* was made by Oldfield on "sand plains towards the Murchison River" (Mueller, 1862). More recently, Canberra Botanic Gardens specimens have been collected in a similar situation and in a coastal gorge at Kalbarri; these locations are in the Irwin district of the South Western Province. *P. maxwellii,* on the other hand, has been collected as far south as Cape Arrid, where Maxwell made his original collection (Mueller, 1872). Added to this, C.B.G. collections have been made near Esperance, and inland near Kalgoorlie in the Coolgardie district of the Eremean Province. These few collections suggest a northerly distribution for *P. porphyrocephalus* and a southerly one for *P. maxwellii,* but at this stage the suggestion must be tentative.

Relationship with other Genera:

As a member of the family *Myrtaceae, Phymatocarpus* has links with several genera in the tribe *Leptospermeae.* In anther morphology it lies between *Beaufortia* and *Regelia;* in ovule number and placentation it has links with *Melaleuca;* and the almost free stamens of *P. maxwellii* show some affinity to *Conothamnus* and *Eremaea.* In addition, *P. maxwellii* has been confused superficially with *Kunzea recurva.* Despite confusing similarities, *Phymatocarpus* can be separated from related genera mainly by the use of anther morphology. To this end an arbitrary key has been set out, based on Bentham (1866), Blackall and Grieve (1953) and on a study of live material at C.B.G. This key is presented below together with a series of illustrations that may aid in recognition of the important anther differences. To study the smaller anthers and to determine the small though distinct differences in dehiscence and position of anther cells a 20X lens is needed. The broad separation of versatile and basifixed anthers, however, can be readily made with a 10X lens.

Key to Phymatocarpus and Related Genera

(based mainly on anther and staminal characteristics)

A *Anthers versatile,* cells parallel opening in longitudinal slits.

B *stamens free:* capsules not woody, the valves deeply sunken beneath rims; leaves mainly alternate. *Kunzea*

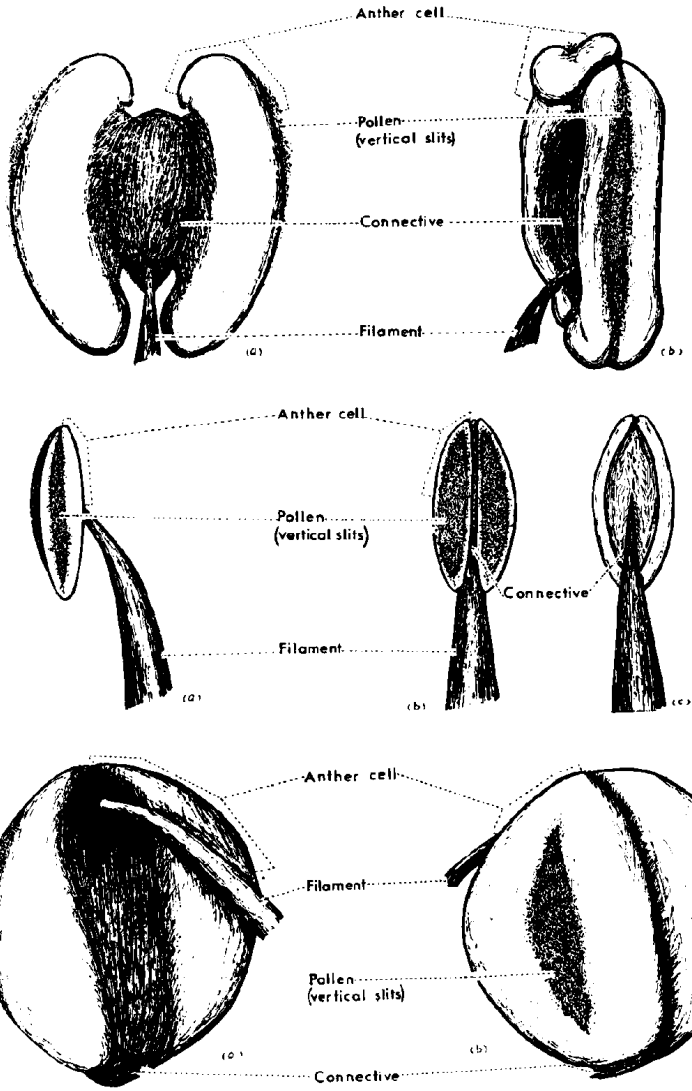
BB *stamens united* in five bundles, opposite the petals; capsules woody, valves various but rarely sunken as deeply as in Kunzea; ovules several in each locule, leaves alternate or opposite. *Melaleuca*

BBB *stamens united or free* but always in five bundles opposite the petals; capsules as in Melaleuca but ovules solitary in each locule, leaves opposite. *Conothamnus*

AA *Anthers basifixed, erect,* cells parallel or back to back, opening in transverse or longitudinal slits or in pores, capsule woody, ovules—one or more in each cell.

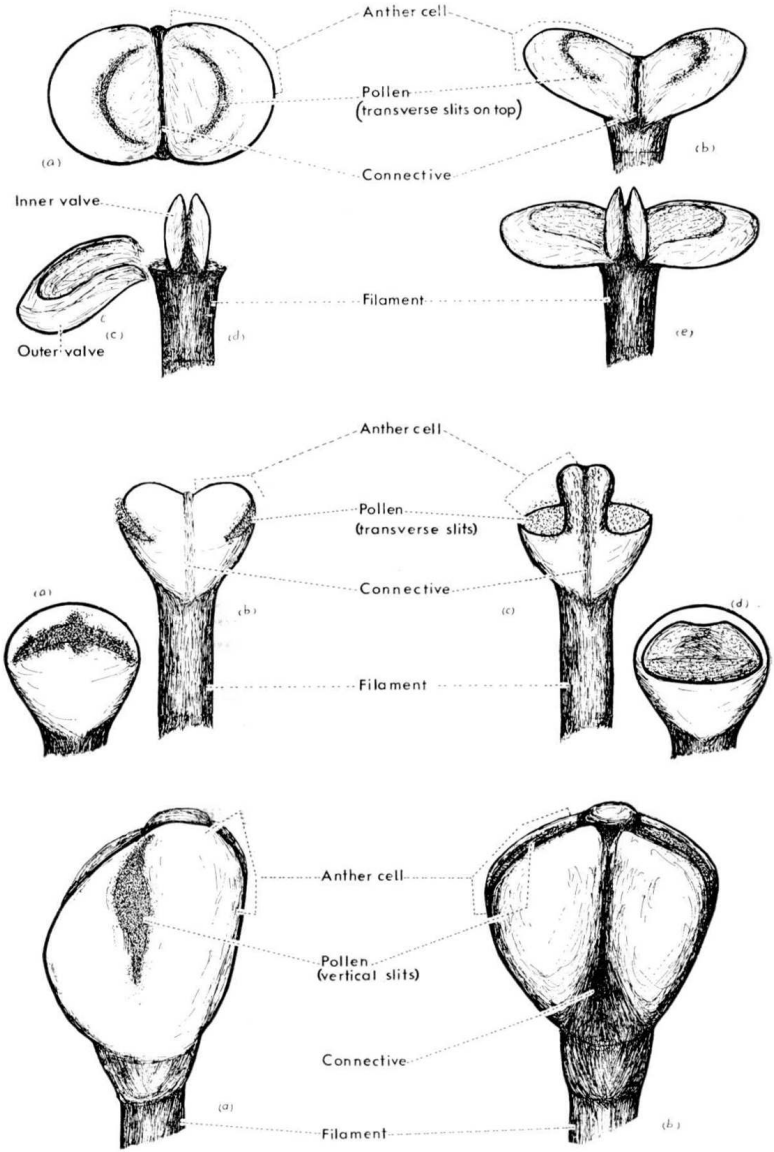
C *Anthers opening in transverse slits,* stamens united in five bundles opposite the petals, in *Phymatocarpus* sometimes almost free within the bundles.

D *Anther cells parallel,* transverse slits on top, the larger outer valve of each cell sometimes deciduous; ovules usually one perfect in each locule, *leaves opposite.* *Beaufortia*



ANTHERS VERSATILE

1. *Kunzea recurva* (a) back view; (b) oblique view.
2. *Melaleuca spathulata* (a) side view; (b) frontal view; (c) back view.
3. *Conothamnus trinervis* (a) back view; (b) oblique view.



ANTHERS BASIFIED

4. *Beaufortia micrantha* (a) top view; early dehiscence; (b) frontal view, early dehiscence; (c) and (d) showing appearance when outer valve is deciduous; (e) frontal view, late dehiscence.
5. *Phymatocarpus maxwellii* (a) frontal view early dehiscence, (b) side view, early dehiscence; (c) side view, late dehiscence; (d) frontal view, late dehiscence.
6. *Eremaea fimbriata* (a) frontal view; (b) side view.

DD *Anther cells back to back,* transverse slits opening outwards; ovules several in each locule, *leaves alternate,* sometimes with very short internodes.
Phymatocarpus

CC *Anthers opening outward in longitudinal slits or pores,* cells back to back, sometimes oblique; stamens united in five bundles opposite the petals, sometimes irregularly united or almost free.

E *Anthers opening in slits or pores, cells sometimes oblique,* ovules four in each locule; *leaves opposite.* *Regelia*

EE *Anthers opening in slits, never in pores,* stamens sometimes irregularly united or almost free; ovules several in each locule, *leaves alternate.*
Eremaea



Phymatocarpus porphyrocephalus

This plant was at Kalbarri on the mouth of the Murchison River, some 350 miles north of Perth. It will tolerate poor sandy soil, 4 months wet, but good drainage, 6 months dry. Will take lime, and salt (coastal spray).

The Species:

Characters separating the two *Phymatocarpus* species do not appear to be widely known and there seems to be confusion about a character common to both species.

For many years the description of *P. porphyrocephalus* in Bentham (1866) together with the original generic and specific descriptions (Mueller, 1862 and 1872) have been available to botanists. Bentham, however, did not know of *P. maxwellii* and no generally useful comparative diagnosis or key was published until Blackall and Grieve (1953). In the latter publication the keys are simplified and brief to make them usable by enthusiastic amateurs and professionals alike, and to separate the *Phymatocarpus* species "stamen number per staminal cluster" is the only character used. This is a good diagnostic character, but for confident determination, more is needed. A strong and useful character is the completely though shortly joined "staminal ring" monadelphous stamens) of *P. porphyrocephalus* in comparison with the "distinct to the base" clusters of *P. maxwellii*. Another character that is diagnostically valuable when present is fruit form and size, in which the two species differ markedly. Blackall did not describe the fruits of *P. maxwellii;* possibly he had not seen them. Certainly there were no fruits on Maxwell's original specimen (Mueller, 1872), so it is possible that they have not been described, at least not in generally available literature. In view of this, the C.B.G. collections of *P. maxwellii* are especially valuable as they have mature fruits. These differ from fruits of *P. porphyrocephalus* in that they are smaller, have no warty outgrowths, and are in more or less cylindrical clusters.

In their generic keys both Bentham (1866) and Blackall and Grieve (1953) suggest for *Phymatocarpus* "leaves small and opposite". In C.B.G. specimens, however, the leaves are not opposite but the specimens go well with descriptions by Mueller (1862 and 1872). Mueller in his generic description (1862) said of the leaves: ". . . sparsis sub imbricato-confertis", which can be translated as ". . . *scattered* sub-imbricate—*crowded*". This apparent contradiction in terms can be explained when the term *"scattered"* is understood in the strict botanical sense in relation to leaves as defined in Bentham (1863): "when arranged irregularly round the stems". Bentham adds, "frequently, however, botanists apply the term *'alternate'* to all branches or leaves that are neither opposite nor whorled". The latter term is used as such in this article.

When studying specimens of *P. porphyrocephalus* it is not hard to understand why confusion over relative leaf position arose. Between the leaves of this species the internodes are so short, especially towards the ends of branches, that the leaves do not appear opposite. On close examination, however, they prove to be definitely alternate. In *P. maxwellii*, on the other hand, the internodes are longer and the alternate state of the leaves is more obvious.

To aid in determination of the species, a key and descriptions are presented below based on Bentham (1866), Mueller (1862 and 1872), Blackall and Grieve (1953) and on observations made at C.B.G. Herbarium.

Key to Species

A Stamens shortly monadelphous, the free parts in five bundles of ten to fifteen; fruit with large warty outgrowths, the orifice wide, clusters globular. *P. porphyrocephalus*

AA Stamens in five distinct bundles to base—not monadelphous—usually three almost free stamens in each bundle; fruit with no warty outgrowths, smaller than in *P. porphyrocephalus*, the orifice relatively narrow, clusters more or less cylindrical. *P. maxwellii*

Descriptions

P. porphyrocephalus F. Muell. (Gk. porphyro- = purple, and -cephalus = headed)

A shrub of 0.7 to 1 metre high with slender branches; leaves alternate with extremely short internodes, more or less imbricate, broadly ovate to orbicular, very shortly petiolate, one-nerved, flat or concave, thick, 2 to 4 mm long; flowers purple (cream or white sometimes?) in a dense globular terminal head about 1.3 cm diameter, the rachis woolly and continuous as a vegetative shoot after flowering; calyx woolly, the tube turbinate about 2 mm long, the lobes broadly triangular—ovate, glabrous, with raised midrib, about 2.3 mm long; petals cordate to squarish-ovate, green with membranous ciliate margins, about 2 mm long; stamens 4 to 5 mm long, the monadelphous base about 1 mm long; fruit about 5 mm diameter including outgrowths, the orifice about 2.5 mm diameter, globular clusters about 1.2 cm diameter.

P. maxwellii F. Muell. (Probably named in honour of the collector, G. Maxwell).

A shrub 1-2.7 metres high with slender branches; leaves spreading elliptic to narrow-elliptic or oblong to lanceolate or narrow-lanceolate, obtuse, concave, thick, one-nerved, petioles about 1 mm long, blade (3) 4 to 6 mm long; flowers pink-purple (smaller than in *P. porphyrocephalus*) in a dense globose head of about 1 cm diameter, the axis woolly, and continuous as a vegetative shoot during or after flowering; calyx silky villous including the lobes, tube about 1.5 mm long, lobes triangular—ovate about 0.6 mm long; petals orbicular 1.5 to 2 mm diameter, often a little villous dorsally, pale reddish brown with broad membranous ciliate margins; stamens 4.5 to 5 (6?) mm long; fruit about 2.5 mm diameter, the orifice about 0.8 mm diameter.

A specimen of this species grew well at C.B.G. in a sheltered position without overhead cover from 1964 until the unusually cold winter of 1971.

Acknowledgements

Thanks are due to Dr. B. Briggs of the New South Wales National Herbarium who kindly checked and confirmed my determinations.

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Blackall and Grieve. How to Know W. Aust. Wild Flowers, Vol. 1: 270 and 304.
Mueller, F. Fragm. Phyt. Austral. Vol. 3: 120 and 121 also Vol. IX: 45.

HOW TO GROW STURT'S DESERT PEA FROM SEED

by J. H. Webb

The seed of the Sturt Pea has a very hard coat which protects it from germinating with say only a few points of rain in Summer. Under natural conditions a percentage of seeds exposed to weathering and abrasion in the soil, become chipped, breaking the hard coat. These few do in fact germinate with only a few points of rain, the rest are left undisturbed as a stockpile of seed for later occasions.

We aim to reproduce these conditions as closely as possible to ensure maximum germination. So by rubbing your seed sample between two sheets of fine sand paper lightly, not hard enough to destroy the seed, but only to scratch it, then placing it in a glass on water, you will see that some seeds will swell after a few hours.

If these swollen seeds are removed daily or as they swell, and planted in a container of pure sand, and watered, you will get an extremely high percentage to germinate. Those seeds that do not swell are rubbed again until they do.

The use of boiling water is not needed or is it desirable, because there are beneficial bacteria present on the seed that help the plant to grow. These bacteria (Rhizobium) belong to the Cow pea group which are different to and nowhere as plentiful as the species that nodulate clovers. By the use of boiling water you may kill the bacteria and the plant will not thrive if the same bacteria are not present in your soil.

DRAINED SOIL

The soil where they are finally planted out can be light or heavy but must be well drained and free from excess salting, and of a reasonable depth.

When established a very light application of superphosphate will help when growing on other than sand, but do not apply Sulphate of Ammonia or all purpose fertilisers, and remember to be very sparing with the water. In the absence of rain a good watering once every two to three weeks will be ample.

If you are growing Sturt Peas in a container it needs to be deep, five gallon drums are suitable. Another method is to use a terra-cotta drainpipe

full of soil standing upright in another container. When the roots reach the end of the pipe the watering is done only on the bottom container. This method helps to prevent loss from root rot which is prevalent if they are over-watered.

Under Canberra conditions plants can successfully overwinter provided they are at least three months old before frosts. In their second year the plants produce more flowers, but decline in vigour after this. Many colour variants are known from natural populations, but the author has little success in keeping the colour variants in cultivation under Canberra conditions, as flower colour appears to be a recessive character linked with lack of vigour, the plants dying under conditions where the normal type thrive.

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CROWEA EXALATA



Crowea—after an English botanist J. CROWE. *Exalata*—wingless its pertinence is doubtful and possibly concerns the fruit.

The 'Small Crowea' or 'Waxflower' is a native shrub of Victoria, related to the Boronias, and valued for the quality and quantity of its flowers. One of its brighest displays comes when most welcome, during autumn and winter. It is frost hardy and suited to cool and moist rather than hot conditions. Of slight and flexible growth it spreads outwards more than upwards, to about 3 ft. across by 2 ft. high, and this is a good size to keep it at. The general effect is dome-shaped, sometimes arching gracefully but more often twiggy and irregular.

This species opens its perfect flowers most months of the year, resting only in extremes of heat and cold, and with flushes in autumn and spring. Pointed buds open to five-petalled starry flowers three quarters of an inch across, in clear tints of rose purple. They are of solid waxy substance, and make a vivid display for the size of the plant. Before falling they close again to look like buds of deeper pink. Seed has not been found here, but propagation by cuttings is easy, using tip growth, which is very soft in character, at a half-ripe stage.

This is a small shrub and it should be planted in light lime-free soil. A position with some shade is desirable—otherwise the soil should be shaded in some way from hot sun. This may be done by surrounding the plant with 2 ins. of leaves, bush litter or compost. Also rocks are on attractive setting.

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