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PLANTS FOR SMALL GARDENS

Even large gardens have border edges requiring small plants. Rockeries, the ideal way to grow many heathland wildflowers, need small plants of character that flower well. There are many wildflowers ideal for this purpose. This issue presents those beautiful little plants known botanically as *Conostylis*. The previous issue presented *Anigozanthos* our "kangaroo paws" also ideal for small gardens.

THE SMALL GARDEN

One member, Gwen Elliot, has produced a whole book, "Australian Plants For Small Gardens and Containers", available from the Editor for \$12.59 + 0.75 postage. Thistle Harris has also produced an excellent book in her series entitled "Small Plants and Climbers", also available for \$25.00 + \$1.00 postage. There have been many references in past issues of this periodical. So we have a considerable reference material but are we more successful with our small gardens?

GROWING WILDFLOWERS IN THE SMALL GARDEN

It is now possible to establish a beautiful little garden of Australian wildflowers. There are a number of reasons why we can be more successful now:

1. The availability of slow release fertilizers such as Osmocote.
2. The work of researchers such as Jim Webb in our last issue where the advantages of slow release calcium such as the use of limestone chips as a mulch could represent a major break through.
3. The availability of work by research scientists, especially those now devoting study to nature's way and the harmony that must exist between all forms of life below ground level. I would refer readers especially to the report on the series of publications produced by the C.S.I.R.O. and to the article by Dr. A. Smith in Australian Plants, Vol. 9, Issue No. 73, page 209.
4. The availability of suitable plants from very good specialist nurserymen. Not only is there a wide range of plants available but more attention is being given to propagation from good forms.

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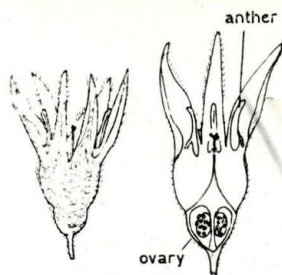
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COVER PLATE — *Blandfordia punicea*

Photography by M. Hodge

This issue is principally about *Conostylis* but a satisfactory photograph was not available. Christmas Bells will grow in similar situations to *Conostylis* except that there is need for more water. What is needed is a method that assures continuous healthy growth and reliable flowering. Who can advise? This seems to be an ideal activity for someone on their own with no experience or facilities. Get some seed. It germinates readily in a pot of sand kept moist. Then plant in numerous pots with different soil texture and vary the fertilizer for each pot. You can become the Xmas Bell expert. The species illustrated comes from Tasmania. An early issue No 13 described all species and conditions for germination of seed and cultivation of plants. This is a project any one in Australia could take on!

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Conostylis

In My Garden

By COL WILSON, MELBOURNE

The genus *Conostylis* is endemic in the south-western portion of Western Australia. The plants are common in most plant communities except wet sclerophyll forest.

Probably the first comprehensive account of the genus was that of Bentham (1873). He recognised 31 of the 46 validly described species at that time.

Green (Proc. of the Linnean Society of N.S.W., 1960, Vol. IXXV, Part 3) examined the genus critically and 23 species are now recognised.

Many of the 23 species (listed in A Descriptive Catalogue of West Australian Plants, by J. S. Beard) can now be found in gardens of some Australian plant enthusiasts. I expect that as they become more widely known one or two will find their way into most gardens.

The genus *Conostylis* was first described by Robert Brown, who placed it in the family Haemodoraceae. Thus *Conostylis* is closely related to *Blancoa* and *Anigozanthos* (Kangaroo paws).

They are perennial herbs and in most cases form small grass-like clumps or tussocks from 10 to 50 cm high. Thus they are ideally suited to pockets in rockeries and small gardens.

The flowers vary in colour from white through yellow to orange and are generally in dense heads at the ends of the stems. In some species they are held above the foliage, while in others they are among the leaves.

The foliage is not usually eaten by slugs and snails, and they will adapt to a range of soil conditions provided they are not exposed to long dry spells.

While they tolerate some shade, some species will not flower unless they receive at least half sun.

Before considering propagation one needs to appreciate that *Conostylis* do not readily produce viable seed. Also their habit can be roughly divided into three classes, namely caespitose, proliferous and stoloniferous.

If viable seed is available it appears to germinate readily. I experienced 70-80% germination in 3-4 weeks with both *C. candicans* and *C. aculeata* subspecies *bracteata*. The only treatment prior to planting was soaking in water for 48 hours. Not selected as a means of breaking dormancy, but resulting from forgetting the seed was soaking.

Propagation by division is relatively easy, although each piece should be well established in a pot before planting into the garden. Those of caespitose habit, i.e. tufted, as grasses when forming mounds can be divided like kangaroo paws in winter. Those of proliferous habit, i.e. in which the stem bears tufts of leaves at intervals at the nodes, can be produced readily if there is a tendency to form roots at the tufts on the stems. *C. aculeata* subspecies *preissii* forms roots a few mm long during wet periods in winter.

If such tufts are removed with about 3 cm of stem attached they can be placed into a propagating medium with the roots at the base of the tuft just covered. The 3 cm of stem is completely buried and provides physical



Conostylis aculeata (above)

Photography by B. Crafter

There are a number of forms of this species the one above being known as sub species *aculeata* because it is the type form. The correct naming of the various forms is the subject of current research. A progress report on this research by Dr. S. Hopper is given on page 263 where other plants similar to *C. aculeata* are described, research that has required the naming of new species. When the entire genus has been reviewed an issue of Australian Plants will give full descriptions. With the information contained in this issue will readers obtain as many plants as possible, grow them and report results. The Latin name *aculeata* means furnished with prickles and refers to the pungent spines on the leaf margins. This species is one of the most widespread and variable ranging from south of Shark Bay to Albany, W.A.

Conostylis vaginata (top right)

Photography by M. Hodge.

As described on page 251 by a reader with considerable experience in the cultivation of this plant, it is ideal for your garden. Small enough for a pocket in the rockery or for pot culture, it does best with some sub soil moisture in warmer months. It is unique in the genus in having white anthers and golden yellow flowers. The species is restricted to heathlands and *Banksia* - mallee low woodlands near the south coast of Western Australia from the Stirling Range eastwards to the Munglinup area.

***Conostylis* species flower heads** (bottom right)

by C. J. Wilson

Col. Wilson has picked flowers from various plants in his garden to get this unusual photograph that allows us to see how the species compare one with the other. In our last issue we introduced all the genera of plants in the plant family Haemodoraceae that are found in Australia, with sketches showing flower detail of each genus. The sketch for *Conostylis* species is shown in the title head on page 247. This shows the six anthers supporting the pollen bearing filaments attached to the upper edge of the floral envelope, which comprises fused "petals" to form a tubular perianth with six pointed ends. The style, awaiting pollination, is in the centre of the flower and facilitates nature's magic of conducting the fertilising agent to the ovary in the base of the flower, which eventually forms seed. Actually there are three general shapes of perianth found in *Conostylis*: tubular as for *C. bealiana* pictured on page 252, free, and as in the case of all species shown here, campanulate, i.e. the free part of the tube is approximately equal in length to the adnate or fused section.

This photograph shows the actual flower head of six species, one with three different forms on the top row, from left to right: *Conostylis aculeata* (detailed sketch of flower item D on page 265), *Conostylis aculeata* subspecies *bracteata*, *Conostylis aculeata* subspecies *breviflora* (sketched as item B on page 265 and described in detail as a new subspecies on page 266) and *Conostylis candicans* (illustrated on page 253).

On the bottom row from left to right are *Conostylis seoriflora*, *C. serrulata*, *C. setosa* (pictured on page 257) and *C. teretifolia*. The latter has a closed dying flower also which gives the plant the appearance of having rusty red flowers at times.



Conostylis vaginata

Photography by M. Hodge.



C. aculeata



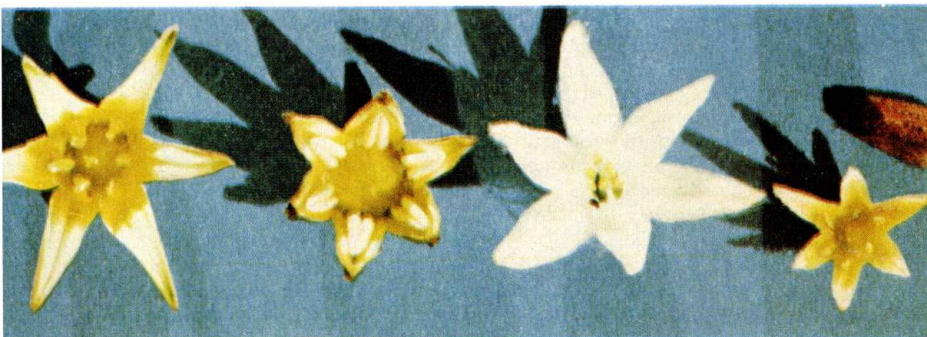
C. aculeata ssp.
bracteata



C. aculeata
ssp. *breviflora*



C. candicans



C. seorsiflora

C. serrulata

C. setosa

C. teretifolia

Flower heads of *Conostylis* species as defined opposite.

support until a new root system is established. This takes 6-8 weeks in a cold frame with regular overhead watering. No hormones and no fertilizers — they survive without either in nature. Most of the tufts of this species that I have produced this way have flowered the following summer.

An alternative method may be to peg down the stem between the tufts to encourage roots to form through contact with the soil. However, this may mean a wait of up to 12 months before cutting off.

Stoloniferous *Conostylis* readily produce roots from the tufts along the stems and so spread by runners. Thus when you establish a plant it spreads and you dig them up if and when you wish. *C. seorsiflora*, *C. stylidioides* and *C. vaginata* are of stoloniferous habit.

The following descriptions relate to garden grown plants and may therefore differ from information in keys.

Conostylis aculeata

Conostylis aculeata grows as a discrete tuft, leaves flat 25-40 cm long, 4-6 mm broad, with 1 mm prominent spines projecting at intervals of up to 1 cm along the edges, sometimes only near the apex. Flowers yellow, 8-10 mm long, hairy, held above the foliage in globular heads. Flowering time is July to December.

Conostylis aculeata* subspecies *bracteata

The stems are sometimes shortly proliferous, leaves 30-35 cm long, 6-12 mm broad, glabrous with prominent spines up to 1 mm long projecting at intervals of up to 1 cm along the edges. On some plants spines may be reduced or even absent. Scape about the same length as the leaves, bearing dense globular heads of numerous yellow flowers. Flowering time August to December. This subspecies forms a link between *C. aculeata* and *C. candicans* on the basis of floral morphology, habit and the presence of intermediate forms in the field.

Conostylis aculeata* subspecies *preissii

An attractive plant in flower, forming a clump 30 cm high by 80 cm across. Proliferous, leaves 10-20 cm long, 2-4 mm broad, with fine marginal spines 1-2 mm long spaced at intervals of 8-10 mm, scape usually slightly shorter than the leaves and bearing 1-2 bracts. Flowers yellow, held in small heads. Flowering time August to December.

Conostylis bealiana

Grows in discrete tufts 20 cm by 40 cm, leaves 12-18 cm long, 2-3 mm broad, longitudinally nerved, glabrous except the margins, which bear fine appressed hairs. Flowers are yellow to orange, solitary, held at the base of the leaves, 2-3 cm long by 1 cm across. Flowering time June-July.

Very attractive in winter while flowering. A five-year-old plant is doing very well in clay-loam with sub-soil moisture and light shade from overhead.

Conostylis candicans

Usually caespitose, the tufts up to 80 cm in diameter and 50 cm high. Leaves 15-40 cm long and 5-8 mm broad, entirely covered at maturity by a pale grey mealy tomentum. Scape, longer than the leaves, bearing 1-2 bracts, sometimes branched. Flowers yellow, 10-12 mm long, held in dense heads. Flowering time August to January.

An outstanding species because of the contrast between the yellow flowers and grey-green foliage. It is tolerant of shade, but does best in a warm sunny position. Fortunately it does set some seed, as it is difficult to propagate by division.

Conostylis juncea

Grows as a discrete tuft up to 10 cm diameter at the base; leaves terete or flat, 10-40 cm long, 2-10 mm broad, glabrous or sparingly hirsute especially at the base, usually fairly prominently nerved. Flowers emerge to just above ground level or may be borne on a loosely woolly scape up to 15 cm long. The inflorescence subtended and often enclosed by two or three broad ovate lanceolate membranous bracts with green midribs. Individual flowers are bright yellow or greenish-yellow 15-20 mm long. Flowering

time July to November. This species appears to require more moisture in the soil during spring and summer.

Conostylis prolifera*, previously *C. stylidioides

A plant varying from compact to an open scrambling form. It may grow as 3-4 cm high tufts, singly, or connected by stolons, or rising to some height by proliferous branching. Leaves 1-10 cm long, 1-2 mm broad, sometimes bearing minute erect hairs on the margins. Flowers yellow, 10-12 mm long, borne in a small head on a simple scape as long as, or much longer than, the leaves. Flowering time August to December.

Conostylis seorsiflora

Stoloniferous in habit and forming a prostrate mat 8-10 cm high by up to 1 m across. Leaves 4-8 cm long, 1-2 mm broad, may be tomentose, but mature leaves usually glabrous. The single flowers are bright yellow, about 13 mm long and held on short scapes which bear a medium leafy bract about 15 mm long with two linear bracts subtending the flower. Flowering time September to December. Requires more than ½ sun or flowering is greatly reduced.

Conostylis serrulata

Grows as a discrete tuft 25 cm by 30 cm; leaves glabrous except the minutely denticulate-serrulate margins, 10-25 cm long, 6 mm broad, longitudinally striate and pinkish at the base. Flowers are pale yellow borne in heads on a scape 3-8 cm long, scape bearing 1-2 chaffy bracts up to 2 cm long. Flowering time October to January. An interesting but not spectacular species due to the pale colour of the flowers.

Conostylis setigera

Grows as a discrete tuft 20 cm by 25 cm; leaves 6-25 cm long, 1-2 mm broad, dark green, glabrous, except for marginal hairs 1-2 mm long, often arranged in several clearly visible vertical ranks on each margin. Flowers yellow, covered in woolly hairs 10-12 mm long borne in heads of 5-10 flowers on a scape that is usually shorter than the leaves. Flowering time May to October.

A very adaptable and worthwhile garden plant. Sometimes available in a form which only grows to about 8-10 cm high.

Conostylis setosa

Grows as a discrete tuft consisting of only a few leaves and usually less than eight scapes. Leaves red at the base, 15-30 cm long, 3-5 mm broad, longitudinally striate and glabrous except for two or more ranks of white hairs 1-2 mm long on each margin. Flowers white or white tinged with purplish red, up to 2 cm long, covered with fine hairs and borne in heads up to 6 cm in diameter on scapes longer than the leaves. Flowering time September to November.

Conostylis teretifolia

Caespitose, stems short or shortly rhizomatous; leaves terete, sulcate, 5-15 cm long, less than 1 mm broad, reddish at base and bearing white hairs up to 4 mm long. Flowers initially yellow, but turning rusty red with age, 10-11 mm long, covered with fine hairs and borne in heads on scapes as long as, or longer than, the leaves. Flowering time August to November. A very attractive plant with the bonus of a change in colour as the flowers age. However, as the plant increases in size, it has a tendency to die in the centre, so divide the plant every three years.

Conostylis vaginata

A straggling plant rarely more than 10 cm high, the rhizome rooting at intervals and spreading to 30-40 cm across. Leaves terete, 3-10 cm long, ½-1 mm in diameter, produced in tufts from the old leaf bases. Flowers bright yellow, 10-13 mm long, borne in small heads on a scape much shorter than the leaves. This is a very distinctive species by virtue of the terete leaves and straggling habit. Sometimes the plant will die in the centre, resulting in a ring-like appearance.*



***Conostylis bealiana* (above)**

Photography by B. Crafter.

An unusual species in having long orange tubular flowers that are not unlike the red flowers of *Blancoa canescens* pictured in the last issue. *C. bealiana* occurs mainly near the south coast of Western Australia from Bremer Bay to Cape Arid. A group of isolated populations has been located recently inland in the Southern Cross area. These include a white flowered form with grey hairy leaves that is probably an undescribed subspecies.

In the garden it is an appealing plant when in flower because of the long tubular flowers. It is not vigorous but lasts well when established. Excessive moisture following flowering may cause the flowers to rot in amongst the leaves which could affect the base of the plant resulting in its death so pick off the dead flowers in a wet period.

***Conostylis androstemma* (top right)**

Photography by N. Marriott.

The photograph shows the inland and south coastal form of the species presently known as subspecies *argentea*. It is probably a distinct species from the typical *C. androstemma* which is characterised by large solitary flowers with spreading perianth lobes and very long stamens and styles.

***Conostylis candicans* (bottom right)**

Photography by C. J. Wilson.

One of the easiest species to grow *C. candicans* occurs in at least two forms. The form found near to the coast has short narrow leaves and a proliferous habit. The inland form has long leaves that are grouped tightly into a caespitose clump. The species ranges from Shark Bay down the west coast to Yalgorup and inland to York. It frequently hybridizes in the wild with *C. aculeata* and *C. prolifera*.

While most *Conostylis* are suited for rockeries *C. candicans* is really too large as it requires up to one metre of space. However the plant pictured is doing very well in a sheltered corner between a large rock and a bluestone drive which provides a very warm situation.



Conostylis androstemma

Photography by N. Marriott.



Conostylis candicans

Photography by C. J. Wilson.

Conostylis

By BRIAN WALTERS,

Sydney

Propagation

The genus *Conostylis* has not received the attention it deserves from native plant enthusiasts. Closely related to the Kangaroo Paws (*Anigozanthos* species), and with a similar growth habit, the genus has a number of species worthy of cultivation. Seed of *Conostylis* species is apparently difficult to collect and it is only in the past few years that seed of a few species has become available. Even so, it can rarely be obtained in any quantity.

Propagation

(a) SEED — Over the past few years I have adopted the technique of pre-germination of seed prior to planting. Such methods are suitable for all but very fine seed and have been described in past issues of 'Australian Plants' . . . see, for example, the 'egg-carton' method in the December, 1974, issue.

Although seed of *Conostylis* is small, it is quite easily handled once the root has appeared. Generally, pre-germination has been carried out during winter with the pre-germinated seed being transferred to individual 38 mm diameter tubes as soon as possible (using a seedling mixture of 85% sand, 15% peat). The tubes are placed in a protected situation outdoors, with watering carried out exclusively by capillary methods. Growth of the seedlings is slow during the first few cold months, but they develop quite rapidly as soon as warmer conditions arrive. Losses during this first 2 to 3 months have been minimal.

Species that have been attempted are *C. aculeata*, *C. aurea*, *C. candicans* and *C. setosa*. In all cases germination commenced in about 10 days and continued for up to four weeks. Between 40 and 60 percent of seed germinated. No pre-treatment was carried out.

(b) DIVISION — Only one species, *C. aculeata*, has been propagated by this method with moderately successful results. In late summer, 1979, two of the plants from the original seed sowing in 1975 were lifted and divided into 10 individual plants; three of the divisions have grown on, the remainder died. While better results had been hoped for, it should be noted that the division was quite barbaric (using a spade!). Greater success would probably result from a less vigorous approach. Since *Conostylis* species normally take two years to flower from seed, it will be interesting to see if the divisions flower earlier.

Cultivation

Experiences with cultivation are restricted to two species, *C. aculeata* and *C. candicans*. Of these, only limited information is available so far on the latter.

(a) CONOSTYLIS ACULEATA — As mentioned above, the original seed was sown in 1975. Four plants were put into the ground in spring, 1976, in fairly heavy soil raised 75 to 100 mm above natural soil surface. No special cultivation techniques have been adopted with these plants. All four plants have thrived and have formed quite large clumps about 300 to 400 mm high by about 300 mm wide (two have been lifted for division — see above). The plants first flowered in 1977, commencing in May/June and continuing through to late spring.

In contrast to these four plants, another was planted out at the same time in similar soil (but not raised), and close to the trunk of a *Eucalyptus citriodora*. This plant, while surviving, has neither thrived nor flowered. This poor performance could be related to competition from a number of large trees growing nearby (in addition to the *E. citriodora*).

The flowers of *C. aculeata* are a golden yellow colour grouped together in a 'head'. The flowers are held on stems above the foliage. The foliage, incidentally, is quite prickly and gloves should be used when handling the plants. All plants have been virtually free of pests.

(b) *CONOSTYLIS CANDICANS* — Seed of this species was sown in 1977. Two plants were put out into the garden in early spring, 1978 . . . one in soil similar to *C. aculeata* above; the other in very light sandy soil raised about 150 mm. The former plant has grown quite well, but has not yet flowered; the latter plant died after two months. In contrast, a third plant which has been kept in a pot (in an 80:20 sand and peat mixture) has grown extremely well and is a spreading clump up to 300 mm high. This plant flowered in June, 1979, with bright yellow flower heads of similar colour to *C. aculeata*.

The foliage of this species is greyish and, unlike the previous species, is quite soft to the touch. ■

Herbaceous Plants

by Neil Marriott, Ararat, Victoria

The following notes are on herbaceous plants I am growing in Ararat, Victoria. They are ideal for rockeries or garden edges.

Ajuga

Ajuga australis the "Austral Bugle" is a very widespread and variable herb from the labiatae family. One of the best forms I have found is from the Mallee country where it grows to 30 cm high with grey-green hairy broad toothed leaves and showy spikes of purple flowers throughout the year. It occurs naturally in damp richer sandy spots between sand dunes, and in the garden thrives in a similar situation such as in a well drained rockery that receives adequate moisture. It soon suckers to form a large showy patch. Propagate by cutting or transplanting suckers.

Blancoa

This plant has similar cultural requirements to the *Conostylis* species; 1, a free draining, but fairly rich loam and gravel mix soil (pH approx. 6.7-7.0).

2, adequate moisture in the growing season.

3, adequate sunshine; $\frac{3}{4}$ to full.

4, a gravel mulch at least 2 cm thick.

If these requirements are all met you should expect to find that your *Blancoa* will grow slowly and steadily into an open grey-green clump up to 30 cm across with attractive, although not showy short spikes of orange-red woolly tube-flowers during the winter. Once this clump is well established it can be carefully lifted and divided, making sure however that each division has at least one actively growing shoot and a good root system. All divisions of this type should be well watered in with a dilution of Maxicrop and Formula 20. Featured with a colour photograph in the previous issue.

Borya

Borya nitida, aptly known as the "pincushion plant". This plant is reminiscent of a clump of dwarf "blackboys", with rough black "trunks" up to approx. 12 cm in height topped with a clump of short spiny green leaves. An attractive feature of this plant is the beautiful golden/orange colouration of the leaves in summer as the soil dries out. If left unwatered many of these leaves eventually drop off in autumn when they are replaced by a new growth of green leaves. Its small white flowers in springtime are attractive though too small to be showy.

Borya grows slowly into a small clump which when big enough is fairly easily divided into several plants.



Conostylis aurea (above)

Photography by C. J. Wilson

The Latin "aurea" means golden and refers to the rich colouration of the clumped sessile flowers in large golden heads. It may be found from just north of Kalbarri National Park, to the vicinity of Perth. Two closely related undescribed species occur with *C. aurea* in the Badgingarra - Eneabba region, but differ in having smaller leaves and earlier flowering.

Conostylis serrulata (top right)

Photography by C. J. Wilson

A jarrah forest species ranging from Perth to Albany, with a few outlying populations as far south as Jerdacuttap, its deeply divided perianths and large anthers are distinctive features, see photograph on page 249.

Conostylis setosa (bottom right)

Photography by F. Hatfield

An attractive species with relatively large flowers that are usually white or occasionally white suffused with purple. The stamens occur at two levels in the perianth, a feature seen elsewhere in the genus only in *C. setigera*. *C. setosa* has a restricted geographical range in the northern jarrah forest from Avon River to Dwellingup.

Conostylis

This genus is one of my major interests, although some species have caused me considerable frustration in my attempts to propagate them. On the whole however I have found (due to many big losses at other times of the year) that the best time for propagation by division (the main method with this genus) is from late summer to mid-autumn. The reason for this is that after flowering in spring, most *Conostylis* sp. put on considerable new growth so long as there is adequate moisture. However one must wait until this new growth has sent down roots and is well established before you divide it up, otherwise your losses will be great. In some species, this establishment of independent root systems may take all summer, autumn and winter, in which case spring division is necessary. Therefore, observation of the particular species growth pattern is essential.

Some success has also been had with propagation of *Conostylis* by seed.

The species of *Conostylis* I have grown include *Conostylis aculeata* and its subspecies *preissii*, *C. Bealiana*, *C. bracteata* and *C. candicans*, all well described by other authors in this issue.



Conostylis serrulata

Photography by C. J. Wilson.



Conostylis setosa

Photography by F. Hatfield.

Conostylis setigera — has grasslike leaves up to about 33 cm high. It forms an open, grassy clump which is filled at the base with masses of pale-yellow flowers in spring.

Conostylis seorsiflora is one of the hardiest spreading species which makes a very attractive dense groundcover about 30 cm wide by about 60 cm high. Foliage is small, grasslike and dense. Single attractive yellow flowers are crowded in amongst the foliage in spring.

Conostylis stylioides is undoubtedly the hardiest and most vigorous of all the *Conostylis* species, so long as frosts aren't too severe. It spreads rapidly by stolons to make a light groundcover up to a metre square. Its short grasslike foliage is topped with dull yellow flowers in spring.

Conostylis setosa is another species over which there tends to be some confusion. The plants I am growing have grasslike foliage to about 15 cm high covered with long white hairs, and hairy cream flowers in clusters held above the foliage. Moderately hardy.

Claytonia

Claytonia australasica, the "White Purslane", is a variable and very wide-spread creeping plant that occurs almost anywhere there is constant moisture in the soil — it even grows under water for many months of the year in inundated swampy areas. The best forms for the garden are from the alps where it forms a dense, bright green carpet with masses of white flowers.

There is a beautiful grey-green foliated form with pink flowers that occurs in the N.S.W. alps in several localities. Both forms thrive and form a dense attractive groundcover under cultivation when given a sunny spot with constant moisture. Propagate by dividing up the prostrate rooting stems.

Goodenia

Goodenia are mainly creeping herbs rooting at the nodes although the genus does include a number of upright shrubby species. See page 292.

Goodenia hederacea is a highly variable and very widespread species, suitable forms of which make beautiful green mats with bright yellow flowers in the garden. The best form is *Goodenia hederacea* var. *alpestris* which forms a dense bright green mat up to a metre across with masses of orange-yellow flowers in spring and summer. It likes a moist sunny position for best results. Propagate by chopping up rooted branches.

Goodenia humilis a nice bright green ground cover for boggy areas with masses of yellow flowers in summer. Propagate by dividing up clumps.

Goodenia larata another good ground cover for open moist sites creeping to cover several feet.

Goodenia geniculata — not as vigorous as most other species but suitable for moist semi-shaded sites.

Goodenia rotundifolia — an interesting clump forming plant requiring a moist well drained site and complete frost protection.

Hydrocotyle

Hydrocotyle verticillata. This plant with its strange but quite attractive shiny green "pennywort" foliage thrives in a damp to wet position in acid soil with dappled sunlight. It spreads by surface runners which root at the nodes. The flowers are small, green and insignificant. Seed must germinate readily in a bog situation as I have had seedlings appearing in the nursery in pots of wet soil about 3 metres away from the parent plant.

Hydrocotyle laxiflora. This extremely vigorous plant known as "stinking pennywort" can become a bit of a pest in the garden where it thrives with regular watering, sending runners in all directions until it is a thick carpet of dull green slightly hairy round leaves. Excellent as a soil binder, etc., but rather too vigorous for most ordinary gardens.

Leptorhynchus

Leptorhynchus squamatus has proved fairly easy to grow in a large pot where it receives regular moisture, but when grown in the garden it tends to die out after a while unless it receives constant moisture, has good drain-

age and dappled sunshine. It grows by creeping along the ground and rooting at the nodes. Flowers are sparse during spring being yellow "button" flowers. *Leptorhynchus tenuifolius* — "Wiry Buttons" is a common clump forming herb, but does not seem to have adapted too well to cultivation so far. Naturally, it likes poor, gravelly clay soils with open to semi-shade.

Mazus

Mazus pumilio. The "Swamp Mazus" is an excellent dense green ground-cover for a moist open to semi-shaded situation. It has attractive mauve flowers throughout the year, mainly in summer. Propagate by division.

Mimulus

Mimulus repens, the "Creeping Monkey Flower" is a beautiful prostrate suckering herb that occurs around permanently wet sticky clayey sites along streams and around coastal and inland salt marsh areas.

It has very small grey-green fleshy foliage and stems, and very showy purple and yellow flowers.

Tends to be very difficult to grow under cultivation, even in simulated natural conditions. Possibly it prefers a brackish soil.

Myriophyllum

Myriophyllum species. "Water millfoils" are as the name suggests primarily water plants, thriving in shallow water or muddy conditions in open to semi-shaded sites. There are many different species all with two types of foliage on the one plant; leaves under the water are very finely divided while those above the water are more coarsely divided ferny leaves.

The best species for the garden pond or bog garden is undoubtedly *Myriophyllum propinquum* with its beautiful bright green ferny foliage, although *M. verrucosum* with its reddish-purple foliage, and *M. elatinoides* with its pale green foliage are quite attractive but not as vigorous.

Orthrosanthus

Orthrosanthus multiflorus is propagated readily from seed and by division. Very hardy, it is growing in a number of different soil types. It responds positively to extra watering in spring and summer.

Masses of pale blue lily flowers in November and December.

Patersonia

Patersonia fragilis is a terete-foliaged clump forming plant with deep violet flowers seated down in the foliage during spring-summer. It likes a moist but well drained acid soil in an open position for best results.

P. longiscapa a grey-green strap-leaved clump with purple flowers on stems longer than the foliage during spring and summer. This showy "purple flag" likes similar conditions but it does not need as much water.

P. occidentalis is a taller green strap-leaved clump that has violet flowers on stems carried above the foliage during spring and summer. It likes similar conditions to *P. longiscapa*, which may be only a form of *P. occidentalis*.

Patersonia — species from W.A. This is an attractive low spreading grey leaved clump and it is growing quite well. It is similar to *P. longiscapa* in flower but tends to be hardier and makes a more attractive plant when not in flower. It likes similar conditions to *P. longiscapa*.

All *Patersonia* species are readily propagated by either clump division or sowing of seeds.

Pelargonium

Pelargonium rodneyanum, the "Rosy Storks-Bill", is a widespread small clump forming plant to a 15 cm high. It has beautiful rosy flowers in spring and grows well in a sunny to semi-shaded position with good drainage. Can withstand very dry conditions.

Sowerbaea

Sowerbaea juncea — propagates easily by division of a clump. Superficially similar to chives that we eat in salads, it is a grey-green grasslike clump with mauve flowers in spring and summer. For sunny, moist position.



The wildflower garden of Col. Wilson, see article opposite.

Stypandra

Stypandra caespitosa is propagated by division quite easily. It is a tufted plant of greyish grasslike foliage with starry purple, blue or rarely white flowers held above the plant in November and December. It needs adequate moisture for good growth and flowering.

Stypandra glauca — again, mainly propagated by division. A branching plant with stem-clasping alternate grasslike leaves with attractive nodding blue lily-type flowers. It needs a well drained to dry situation.

Velleia

Velleia paradoxa is closely related to the *Goodenia* and is very similar looking, with showy yellow flowers on 30 cm stems above a clump of deep green leaves to 15 cm high. This plant is quite easy to grow in a well drained but quite moist situation with acid soil and dappled sunlight.

Veronica

Veronica gracilis, the "Slender Speedwell", is an attractive, though far from showy spindly herb. It has thin straggling stems, fine leaves, and small blue cup flowers. It suckers in a moist well drained site.

Veronica perfoliata, the "Diggers Speedwell", is a very attractive clump-forming plant to 40 cm with interesting silver perfoliate leaves and attractive spikes of mauve-blue flowers in spring and summer. Thrives in a dry sunny spot in a rockery, making an excellent foliage contrast plant.

Xyris

Xyris operculata is propagated by division of the parent plant, a very easy method. It is an attractive tufted plant with curling wiry leaves and pretty yellow lily flowers. It needs adequate moisture for good flowering.

X. gracilis is similar and has the same requirements for cultivation. ■

The Wildflower Garden of Col Wilson

Observations by W. H. Payne.

The photograph shows a well laid out and stocked wildflower garden.

Colin Wilson has been fortunate enough to have a sloping area and he has made the most of it. It would not matter what the soil type is underneath. If fortune smiled and it was a rich heavy loam with a water seepage a few feet from the surface then you could grow almost anything. If a clay or very heavy soil, work into it as much mulched material and gravel as you can, preferably in channels sloping at an angle across the fall of the land.

Position large rocks on the slope. It is worth spending up big and getting a load of boulders. Look how Colin has done it. Are not those rocks superb. You fill in between the rocks with a good loam. Many would say a bush sand and who would say they are wrong. With a bush sand, or even any washed sand you will get a spectacular display of the showy plants from the west or the heath lands of the east that will rival any rock garden. With a slow release fertiliser such as "Osmocote", twice a year you should be able to create a flowering paradise. I feel a good garden loam will give best and longest lasting results but suspect we have a lot to learn yet about below ground care and health of soil.

Without any doubt, the photograph does not do justice to this garden. The red of the *Grevillea lavandulacea* should be quite bright and you can only just see the proud heads of the N.S.W. Waratah, *Telopea speciosissima* in the centre background. The living yellow of the two plants of *Conostylis aculeata* on the left and its sub-species *preissii* next to it, is quite attractive. The white flowers in the top right of *Pimelea spectabilis* are something to behold and the presence of such a large healthy plant speaks highly of the health and vigour of this garden. The kangaroo paw, *Anigozanthos rufus* x *flavidus* is a reliable free flowering plant and other species could be placed to advantage in such a garden. Other small plants he has used to advantage are *Grevillea thelemanniana*, a prostrate plant that is not in flower, just above the *Conostylis*, *Kennedia beckxiana*, one of many excellent *Kennedia* for this position, *Banksia repens* one of a few prostrate or suckering small *Banksia* that sit their flowers on the ground like coloured koala bears, and *Boronia spathulata*. Many small *Boronia* including the native rose *B. serrulata*, would grow in the front among those rocks.

For filling in between rock pockets in spots where he wants the plants low so as to show off the rock, he has used *Viola hederaceae*, *Pultenaea pedunculata*, *Pratia erecta* and *P. surrepens*, and *Mazus pumilio*.

To the upper left of the *Grevillea lavandulacea*, the branches of pink and white belong to *Hypocalymma angustifolia* a very reliable showy plant. Other plants of this small stature used are *Grevillea juniperina*, *Isopogon* and *Melaleuca wilsonii*. The background plants chosen are not huge bushes but can be colourful in season with interest in the foliage colour and shape and include *Eucalyptus tetralpeta*, *E. rhodantha*, *Erythrocorys*, *Banksia ericifolia* and *Prostanthera ovalifolia*.

A beautiful garden with all year round interest. Why not create one of your own? See page 269. ■

Two Unusual Plants in Cultivation

By RAE SEXTON, M.Sc., Gilberton, S.A.

I have grown successfully two plants which I think may not have been cultivated before—*Rhagodia gaudichaudiana* Moq. 1840 and *Maireana erioclada* Syn. *Kochia erioclada* (Benth.) Gauba (1948). Both species have self-seeded during the eight years they have been in cultivation.

Rhagodia gaudichaudiana (Cottony Saltbush) is a striking plant at all times of the year, whitish-grey with lax branching, shovel-shaped leaves (even to the upwards curl of the blade) a centimetre long and bright red berries. These fruits are produced throughout the year on long, interrupted panicles. The perianth is densely mealy outside, light green and glabrous inside, turning crimson with white centre and margin and remaining on the bush, star-like, after the bright scarlet depressed berry has dropped. The distinguishing feature of this plant is the large perianth closing right over the fruit and later becoming reflexed when it is 3-8 mm long (fresh material), while the berry is at most 3 mm across. However, the plant is quite unlike *R. spinescens* var. *deltophylla* F.v.M. (cultivated as ground cover), as it is not rigid, has very white stems and leaves, very showy fruiting perianth, and the leaves do not have sharply pronounced (deltoid) lobes, nor are the small leaves ever ovate or oblong.

Maireana erioclada (Bluebush) has a silky white covering over the branches and has clusters of smooth, blue-green terete leaves, 2 cm long; flowering is in response to rain—the two tiny styles appear first, followed by five small stamens, and later a sessile reddish broad-winged fruit with small vertical wings. A few strong branches are produced and the bush grows to 1.5 m in height.

Both of these plants were used to cover plumbing on a difficult site against a brick wall. Many gardens must have similar problem areas where use could be made of arid-zone plants. The soil in this case was alkaline red clay, but the plants were grown in a pile of left-over coarse yellow building sand. The site receives full sunlight facing north and is extremely hot in summer. A wide eave reduces the amount of rainfall. Concrete surrounds the area. The plants are not watered, but sprinkled sparingly during droughts. Following winter rains the seeds germinate in sand and gravel if left undisturbed, but need a previous hot, dry season. Growth is rapid. The *Maireana* has two ovate seed leaves, followed by centimetre-long, silky, terete leaves in decussate arrangement. The first leaves of the *Rhagodia* are hoary and truncate as in the adult.

The *Rhagodia* in particular is a most worthwhile garden subject. ■

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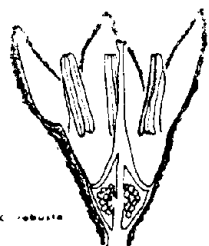
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Presented exclusively for those people who wish to cultivate small picturesque gardens or who wish to grow suitable plants in containers to show when in flower, this 136-page (279 mm x 210 mm) book achieves its aim well. It is obvious that Gwen worked a lot with Roger Elliot, her husband, when Australlora was first established, as this is a very practical book. Those who have been lucky enough to visit their home, "Stringybarks" in Montrose, Victoria, and savoured the delightful use of plants in the small feature areas designed to complement the modern architecture and the natural bush-setting will appreciate the sensitive experience that has gone into writing this book. The 550 species of selected wildflowers that are listed in the 11 charts of plants recommended for a wide range of situations are simply described with their cultivation requirements. An ideal book for a beginner with a small garden.

CORRECTIONS TO ISSUE No. 81.

Page 203 — The main ink spot fungus is *Dreschleria irisid*.

Page 201 — The plant in the colour plate is *Anigozanthos bicolor* and not *A. gabriellae*. *A. gabriellae* is illustrated on page 229.



The *Conostylis aculeata* Group

Taxonomic notes and new taxa in the *Conostylis aculeata* group taken from a scientific paper by Stephen D. Hopper (Nuytsia, Vol. 2, 254-264).

Introduction

The *Conostylis aculeata* R.Br. group consists of a complex of seven species of perennial herbs which are restricted to the western coastal plain and nearby plateau regions of south-western Australia. The group forms part of the section *Conostylis* (Bentham 1873; Geerinck 1969), and is characterised by leaves with marginal spines or setae, numerous ovules borne all over the placental surface, and a basic chromosome number of $x = 8$.

As shown in a published account (Australian Journal of Botany, Vol. 25, 395-411) of extensive field studies, both hybridisation and ecologically-correlated intraspecific variation occur in species of the *C. aculeata* group near Dawesville on the Swan Coastal Plain. It was there demonstrated that while the identification of specimens from this region could be difficult in the herbarium, critical field observations enabled the satisfactory placement of individuals into morphologically definable species and/or their hybrids.

Key to species in the *C. aculeata* group

1. Leaves grey-white, tomentose when young, sometimes becoming glabrous with age; perianth lobes golden yellow inside when fresh.
 2. Leaves 10-50 cm long and 2-5 mm broad; habit caespitose inland, proliferous near the coast; chromosome under $n \neq 8$ (Scott River, Yalgorup—Shark Bay) *C. candicans* Endl.
 2. Leaves 1-5 cm long and less than 1 mm broad; habit proliferous; chromosome number $n = 16$ (Walkaway—Dirk Hartog Island) *C. filifolia* F. Muell.
1. Leaves green, glabrous except for marginal spines or setae; perianth lobes creamy yellow inside when fresh.
 3. Leaves with rigid, indurate, pungent marginal spines; habit caespitose to proliferous.
 4. Leaves terete or subterete, 1-2 mm broad (Cannington—Jurien Bay) *C. filifolia* F. Muell.
 4. Leaves flat, 2-15 mm broad.
 5. Leaves 5-15 mm broad and 15-50 cm long, faintly glaucescent; scapes usually much longer than the leaves (Mingenew—Murchison River) *C. robusta* Diels
 5. Leaves rarely exceeding 5 mm breadth and 5-50 cm long, olive green; scapes usually shorter than or $\pm$ equal to the leaves (Albany—Murchison River) *C. aculeata* R.Br.
 3. Leaves with flexible, membranous marginal setae; habit proliferous.
 6. Leaves 1-10 cm long and 0.5-2.0 mm broad; flowers 7-13 mm long; anthers 1-2 mm long, $\pm$ equal to the filaments (York—Murchison River) *C. prolifera* Benth.
 6. Leaves 10-25 cm long and 1-2 mm broad; flowers 8-15 mm long; anthers 2-3 mm, longer than the filaments (Busselton—Mandurah, ? Yanchep) *C. pauciflora* Hopper

The status of *Conostylis robusta* Diels

Conostylis robusta was made a subspecies of *C. aculeata* by Green (1960) on the basis that it was difficult to distinguish from some extreme

forms of *C. aculeata* and that it appeared to occupy a distinct geographical range.

The two taxa are now known to occur in close proximity to each other at a number of localities, and their neighbouring populations are readily distinguishable on the characters given in the above key. Moreover, a discriminant function analysis (Fisher 1936, Blackith and Reyment 1971) of 10 perianth measurements made on nearby populations of *C. robusta* and *C. aculeata* at Kalbarri indicates that the taxa are distinct in floral structure as well (Fig 1). Since their distributional ranges overlap considerably, the recognition of *C. robusta* and *C. aculeata* as geographical subspecies is no longer tenable. I consider that the morphological differences between *aculeata* and *robusta* are comparable with those used to distinguish other species in the group, and consequently recognise *C. robusta* as a distinct species.

The identity of *Conostylis stylidioides* F. Muell. and *C. prolifera* Benth.

In his revision of *Conostylis*, Green (1960) reduced *C. prolifera* Benth. and *C. racemosa* Benth. to synonymy under *C. stylidioides* F. Muell., stating that "field studies, especially in the Geraldton area, have shown that Benth's distinctions are unworkable". Benth (1873) distinguished *C. stylidioides* from the other two taxa primarily on leaf shape. It was described as having "leaves nearly terete, short and rigid", whereas *C. prolifera* and *C. racemosa* have "leaves flaccid, very narrow but flat, green and grass-like or white only when very young". The latter species differed in that *racemosa* had flowers ½ in. long in a loose raceme whereas *prolifera* had somewhat shorter flowers in a dense head.

My own field surveys in the Geraldton—Shark Bay region confirm Green's (1960) observation that these differences in leaf shape, flower length and inflorescence structure are unreliable taxonomic characters, sometimes varying within single individuals and among different plants of the one population. However, a critical study of populations throughout this region indicates that two morphologically and chromosomally distinct taxa do exist. One has green, usually flat leaves, perianth lobes which are cream-coloured on the inner surface, and is diploid ($n = 8$). The other has white, densely tomentose leaves which are often subterete when young, golden yellow perianth lobes, and is tetraploid ($n = 16$).

On referring back to Benth's descriptions of the three taxa, it was found that the distinction regarding the presence of a densely white leaf tomentum in *C. stylidioides* was clearly stated but not incorporated in the key to species.

To clarify the identity of *C. stylidioides*, this species is redescribed below and its geographical distribution and morphological features are illustrated (Fig. 2A). I consider that *C. prolifera* and *C. racemosa* are conspecific, and since Benth (1873) regarded the latter as a possible variety of *C. prolifera*, *C. racemosa* will be reduced to synonymy under *C. prolifera*. The reader is referred to Benth (1873) for an adequate description of *C. prolifera* and to Green (1960) where this species is described and illustrated under the name *C. stylidioides*.

Figure 1. Results of a discriminant function analysis of 10 floral measurements taken on samples of *Conostylis aculeata* (D) and *C. robusta* (E) as shown on half flower illustrations. Measurements taken were: 1, perianth length; 2, style length; 3, ovary to base of highest anther; 4, ovary to base of lowest anther; 5, ovary to base of lowest filament; 6, perianth lobe length; 7, anther length; 8, perianth width across lobe bases; 9, perianth width at the ovary; 10 perianth lobe width at the base. Figure 2. The geographical distribution of the five species illustrated by half flower and leaf morphology sketches is given as follows:

- A. *Conostylis stylidioides*
- B. *Conostylis aculeata* ssp. *breviflora*
- C. *Conostylis pauciflora*
- D. *Conostylis aculeata* used in analysis
- Only northern populations are shown.
- E. *Conostylis robusta* used in analysis



Comparable organs are at the same scale. a, marginal spine; b, mature leaf; c, young leaf; d, half flower.

***Conostylis stylidioides* F. Muell., (Figure 2A)**

Herb, proliferously branched with stolons up to 20 cm long. **Leaves** grey-tomentose when young, sometimes becoming glabrescent with age, distichous, equitant, conduplicate at the base, otherwise flat to subterete, linear, up to 5 cm long (usually 1.5–2.5 cm), less than 1 mm wide. **Inflorescence** a capitulate cyme on a simple undivided scape 3–20 cm long, usually much longer than the leaves. **Flowers** golden yellow, 9–13 mm long; **perianth** tomentose outside, glabrous within, the lobes 4–6 mm long and $\pm$ equal to the tube, the inner surface golden yellow; **stamens** slightly biseriate, filaments 1–2 mm long, anthers 1–2.5 mm long; style 5–8 mm long, the stigma $\pm$ level with or slightly higher than the anthers; **placenta** covered all over with numerous ovules. **Seeds** not seen. **Chromosome number** $n = 16$.

Distribution and habitat: (Figure 2). The south-west of Western Australia, within 90 km of the coast from Geraldton to Shark Bay and Dirk Hartog Island. The species occurs predominantly in *Acacia*-mallee scrub in dry red or yellow sands, usually on hillslopes or flat plains.

C. stylidioides can be distinguished from *C. candicans* by its short leaves less than 5 cm long and 1 mm wide, while it differs most noticeably from *C. prolifera* in its tomentose leaves and its golden yellow perianth lobes (the latter character is only discernible in fresh material).

New Taxa

Two new taxa belonging to the *C. aculeata* group are described:

***Conostylis pauciflora* Hopper sp. nov. (Figure 2c)**

Differs from *C. aculeata* R.Br. in the flexible, membranous and densely tomentose leaf spines less than 2 mm long, in the leaves less than 2 mm wide and 25 cm long, and in the few flowers per inflorescence.

Herb, proliferously branched with stolons up to 15 cm long. **Leaves** green, equitant at the base, otherwise flat, ensiform, maximum length 15 cm on average (up to 25 cm); **marginal spines** flexible, membranous and densely tomentose, rarely more than 1 mm long. **Inflorescence** a capitulate cyme, usually of less than 10 flowers, on a simple scape (8) 16 (30) cm high, equal to or longer than the leaves. **Flowers** yellow, 8–15 mm long; **perianth** tomentose outside, slightly hairy within, the lobes 4–7 mm long and usually exceeding the tube; **stamens** uniseriate, filaments 0.5–1.0 mm long, anthers 2–3 mm long; style 5–12 mm long, the stigma $\pm$ level with the anthers; **placenta** covered all over with numerous ovules. **Seeds** not seen.

Distribution and habitat: (Figure 2). The south-west of Western Australia; Yalgorup-Dawesville area of the Swan Coastal Plain within 10 km of the coast. The species is known from only a few localities on sandy hillslopes of the Spearwood Dune System, in mixed Jarrah-Marri-Banksia woodland.

Natural hybrids between *C. pauciflora* and *C. aculeata* spp. *aculeata* have been found at one locality. Hybrids displayed a slight reduction in pollen fertility relative to the parental species, and occupied a habitat intermediate in soil moisture between the dry hillslopes favoured by *C. pauciflora* and the wet flats by *C. aculeata*.

The specific epithet refers to the few-flowered inflorescence

***Conostylis aculeata* ssp. *breviflora* Hopper ssp. nov. (Figure 2)**

Differs from other subspecies of *C. aculeata* R.Br. in the smaller flowers 6–9 mm long.

Herb growing in tufts up to 50 cm in diameter, proliferously branched with stolons up to 18 cm long. **Leaves** green distichous, equitant, conduplicate at the base, flat and linear for most of their length, maximum length 13 cm on average (up to 18 cm), 1–3 mm broad; **marginal spines** 3–8 mm apart, rigid, pungent, indurate, glabrous, 1–3 mm long. **Inflorescence** a capitulate cyme on a simple or once divided scape up to 20 cm high, equal to or longer than the leaves. **Flowers** yellow, (6) 7.5 (9) mm long; **perianth** tomentose outside.

glabrous within, the lobes 3-6 mm long and exceeding the tube; *stamens* uniseriate, filaments 0.5-1.0 mm long, anthers 1-2 mm long; *style* 3-5 mm long, the stigma $\pm$ level with the anthers; *placenta* covered all over with numerous ovules; *ovary* scarcely enlarging in fruit. Seeds not seen. *Chromosome number* $n = 8$.

Distribution and habitat: (Figure 2). The south-west of Western Australia, within 70 km of the coast from Dandaragan to the Arrowsmith River. *C. aculeata* ssp. *breviflora* is common in winter-wet flats, swamps, depressions and roadside ditches in sandy soil throughout the Mt. Lesueur — Eneabba heathlands.

Conostylis aculeata ssp. *breviflora* is closely allied to but occupies a distinct geographical range from other subspecies of *C. aculeata*. It is readily distinguished from these by its smaller flowers, (averaging 7.5 mm long in comparison with 9-11 mm for the other subspecies) and by its shorter leaves.

Hybrids of *C. aculeata* ssp. *breviflora* and *C. candicans* are known from Cockleshell Gully and the Hill River bridge on the Jurien—Cervantes road. At both localities the new taxon occupies low-lying alluvial flats while *C. candicans* occurs on adjacent drier hill slopes. Hybrids are confined to narrow zones of overlap where the two species grow intermixed.

The subspecific epithet refers to the characteristic short flowers of the new taxon. ■

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Verticordia in Adelaide

by Brian Crafter

The *Verticordia monodelpha* in the photograph, page 152 of issue No. 80 is growing in my home garden at Lockleys and is about three and a half years old. This plant came from Keith Pitman of West Lakes Nursery in Adelaide.

The parent plant is growing at his home in Holden Hill, a north-eastern suburb of Adelaide. His soil is a heavy clay type, Ph $8\frac{1}{2}$ -9, so he built up an acid bush sand bed (Ph 6) about 30 cm thick and his *V. monodelpha* is still growing nicely after 6-7 years.

My block is sited in normal suburbia, on old pink sand dunes of slightly calcareous nature, so fortunately no drainage problems exist. About 4 years ago I removed half of my back, and all the front lawn, to grow native plants. Most neighbours needed no further proof that I had at last gone around the twist! I decided to try some *Verticordia* in a sunny spot, out in the back yard. In an area of about 8 x 3 metres I cultivated, by deep digging, about a third of a cubic metre of acid topsoil from the hills and a little less than this of peat moss. This reduced the Ph reading to about neutral.

Plants of *V. monodelpha* and *V. chrysantha* were planted and mulched with coarse sand about 25 cm deep. I later planted *V. lindleyi*, *V. densiflora*, *V. plumosa*, *V. drummondii* and *V. wilhelmii*, the only *Verticordia* native to S.A. I lightly fertilised with "Osmocote" after planting. Some plants yellowed during early stages and this I found was easily corrected by sprinkling iron sulphate around the base of the plant and watering in. Any subsequent yellowing was treated the same way with good and fairly rapid results.

The main cause, I feel, for this chlorosis is Adelaide's rather saline tap water, particularly during the summer. I now only water after a prolonged dry spell and preferably during a cool change.

I mulched the bed 18 months ago with medium to coarse gravel.

V. drummondii has since seeded and re-generated with 5-6 seedlings about 9 cm high.

Verticordia monodelpha has done exceptionally well and has been the pride and joy of the small collection. *V. plumosa* and *V. wilhelmii* have also done very well with *V. chrysantha* and *V. lindleyi* doing moderately well. I have tried a couple of times with *V. nitens* but after flowering nicely at 18 months both died, presumably root rot even with little summer watering.

This winter I rather severely pruned my *V. monodelpha* to give away several large bags of cutting material to friends. The plant has sprouted well and is starting to bush out nicely again.

After having travelled back to the West several times in the last three years to see these plants growing in their natural habitats, I realise what a gigantic task it would be to try to duplicate each specific set of conditions they occupy. Almost impossible! *V. plumosa* in soggy peaty pockets on gigantic granite outcrops in Albany with 120-150 mm rain, to deep yellow sand in 25 mm rainfall in the north for *V. occulata*. *V. plumosa* occurs in the Stirling Ranges in two distinct forms, a white plumed form in swampy areas and an open-flowered pink form in sandy dry areas. *V. plumosa* seems by far the hardiest of all the *Verticordia* and the most versatile with *V. monodelpha* a fairly close second. It has enormous potential for landscaping.

It seems many *Verticordia* can be grown to top horticultural standards if they have "good garden conditions". I feel many grow in spite of their habitats, not because of them. Drainage, either by surface slope, or good soil texture, preferably both, is important with a Ph of near neutral, together with little summer water seems essential to grow these superb plants.

It does not seem too difficult to strike cuttings from established garden plants. The big trick of course is to find the friend with the inclination to prune their plants for cuttings. However, they do become progressively more tricky and touchy to pot on from the rooted cutting stage and despite all care quite a few fail to survive, it seems, for many reasons. From the 3½-year-old *V. monodelpha* I have grown several plants and from a 1½-year-old offspring the cuttings show a greater propensity to strike and survive the potting on stage. It suggests that with constant selection and cultivation, some of these rarely seen *Verticordia* will become more reliable. Once established they appear quite hardy.

I have a cold cutting frame, plastic covered, of about 1mx½m/½m and have had some success with this method. However, I find I seem to do best in late Autumn to early Winter, with 10 cm pots placed in plastic bags with several small ventilation holes at cutting level, and tied at the top. I keep these in sheltered semi-shade and only water when quite dry. Having tried just about all types of cutting medium I concluded that they don't seem to make much difference to the result. Keeping the medium towards the dry side for water, appears to be an important factor. Unfortunately, I would love to have time to experiment on and on, but I can only devote a small amount of time to my favourite pastime of propagating and growing Australian plants. ■

Successful Wildflower Gardens — Notes by Editor

In issue No. 80 we produced a colour plate of *Verticordia monodelpha*. It possibly was not the best photograph available but to me it was exceptional. Why? Because it was a photograph of a well grown healthy plant in a reader's garden as described opposite. As with Col. Wilson's garden described on page 261, Brian Crafter's garden is undoubtedly a successful wildflower garden to sustain mature plants of *Verticordia*.

This is what our publication is all about.

Over the next twelve months I want photographs of all the best and most successful wildflower gardens. If you do not have one but are a competent photographer, then I will pay film and processing expenses for 35mm. slides or negative print film to any quantity you need. Photographs should show views from various aspects of a garden trying to capture its display, and separate photographs of well grown plants or plants that are a special feature for one reason or another.

Over the twenty one years I have been producing Australian Plants I have tried to whip up some enthusiasm in readers to contribute. If I could get those who enjoy this publication to work as hard as my critics we would have achieved much more than we have. This is our 21st year. Let us all make a special effort.

Systematic Selection and Testing of Australian Plants

The concern shown at the 1979 Federal Conference that "a more systematic exploration, collection, propagation and testing of desirable species and forms of Australian Plants" is a major concern of this society was reflected in the appointment of David Mackenzie and Henry Nix as liaison officers. It is hoped to publish further reports of this vital work in future issues.

Colour Slides Needed

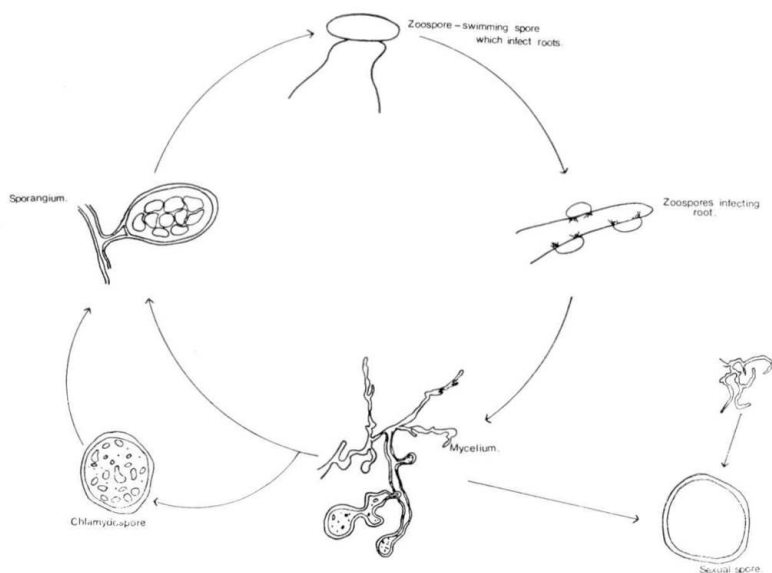
Good colour slides are desperately needed. If you are a good photographer please send a few slides for inspection. We need all species but in particular need slides of all species in the families — Fabaceae (especially *Pultenaea* & *Mirbelia*), Goodeniaceae, Rutaceae, Malvaceae, Myrtaceae (especially *Calothamnus* and *Beaufortia*), Proteaceae (especially *Adenanthos* and *Grevillea*), Orchidaceae, and any other good ones you have.

THE "CINNAMON" FUNGUS *PHYTOPHTHORA CINNAMOMI* AND THE HOME GARDEN

By GRETNA WESTE, Botany School, University of Melbourne

Phytophthora cinnamomi is commonly called the cinnamon fungus because it was first isolated from a cinnamon tree growing in the mountains of Western Sumatra in 1822. Since then the fungus has travelled far and wide. It causes problems in England and Switzerland in rhododendrons, ericas and orchards, in Californian avocado orchards and in Australian gardens, orchards and native forests, particularly in Western Australia, Victoria and Queensland. We do not know how or when the pathogen arrived in Australia, but it obviously cannot co-exist with healthy native vegetation in many areas. In fact the fungus could very easily have been carried into Australia on roots and soil associated with introduced plants.

The pathogen causes decay of the fine, unprotected roots of hundreds of different plants. Root rot is not obvious, and neither is the fungus. It consists of very fine threads visible only with the aid of a microscope. The first obvious symptoms are secondary, and show as a yellowing and dieback of shoots when the infected plant is already severely diseased and suffering from being unable to absorb water and minerals due to the decay of its fine, absorbing rootlets. At this stage, that is when disease is obvious, the cinnamon fungus is already widespread in the soil and is difficult to treat.



How does the fungus get there? If a plant from an infected nursery, or from an infected garden or forest, is transferred to your garden you will of course transfer the thread-like fungus either inside the roots or in the soil with the plant. Since it is microscopic, you will not see it. If you buy a load of mountain soil or sand, or gravel which contains the fungus, the latter can live and even multiply for quite a while — at least six years in soil or gravel — and will travel to infect nearby plants. How does it travel? The threads can grow through the soil, but the most rapid form of spread is by tiny swimming spores which either swim or are carried in water. These are chemically attracted towards roots, which they penetrate near the root tip. On the root surface the spores produce the fine threads

which grow throughout the root tissue causing decay, and in turn produce more swimming spores to infect other plants. Since the spores travel in free water, the disease spreads most rapidly downhill, but the fine threads will grow in any direction and so the disease will spread uphill, but much more slowly. This can all be observed in an infected forest, such as in the Brisbane Ranges, where the grass trees or blackbovs serve as colourful indicators. Their leaves turn yellow, then cinnamon-brown, and the plants droop and die downhill from the infection source first and then more slowly uphill. The fungus is most commonly spread in the bush by using infected gravel on the road verges, but may also come from infected soil carried on tools, tractors, etc. From the road verge rain washes the spores downhill into the forest and so the disease is spread. Widespread infection occurs during warm, wet periods, which suit the swimming spores. However, infected plants often die during dry periods because these are the periods when the shortage of fine roots is fatal. Apart from the swimming spores there are other more resistant chlamydospores which tide the fungus over dry periods and last for a long time inside small pieces of root.

The cinnamon fungus is widespread in Victoria, but scattered, and there are many large areas from which it is absent. How do you detect it? We cannot be sure of its presence unless we isolate it from the roots and examine the culture so obtained under the microscope. The method is therefore to set up samples of soil and roots in small icecream cups, cover the soil and roots with water and add, as bait, either tiny eucalypt seedlings or lupin seed which has just germinated. The swimming spores infect these, and the fungus can then be isolated, grown on plates of nutrient, and identified with the aid of a microscope. How do you treat an infected plant? The easiest treatment is to dig up the plant and its neighbours and burn them, particularly all the roots. Try to remove all roots from the soil, then disinfect the soil. This can be done with common soil sterilisers, such as methyl bromide and chloropicrin, or using nematocides (which destroy round worms or nematodes) such as basomid or vapam. However, if your plant is precious, the new systemic fungicide "ridomil"*, developed by Ciba-Geigy, is very effective in destroying 95% of the pathogen without affecting the plant and can be applied in low concentrations either to the leaves or soil. Of course, any pieces of root left in the soil may contain the resistant chlamydospores.

Some soils are "suppressive"; this means that although the pathogen may be present in the soil no disease occurs. This has been investigated for avocado orchards on red basaltic soils of Mt. Tambourine, Queensland (Broadbent, 1974). Suppressive soils had high organic content, high ammonium, calcium, magnesium, iron, ethylene and high populations of micro-organisms. The suppressive soil became conducive with certain practices, such as failure to add organic matter, and some conducive soils were made suppressive by the addition of organic matter. The suppressive quality depends at least partly on the microbial population, and this is an example of biological control. Soil micro-organisms compete with and many actively antagonise fungi. Some bacteria actually attack the pathogen, feeding on the hyphae and sporangia. We need more information on how to make garden soil suppressive to the cinnamon fungus, but these few facts may help you to build up your garden soil and suppress disease.

Dieback disease due to the cinnamon fungus is common in suburban gardens, probably because it is common in nurseries with poor sanitation. A badly managed nursery with crowded plants and no hygiene provides a feast for the pathogen, with all its food supply readily available. As the infected plants are sold, the pathogen becomes widely dispersed in the home garden. To eliminate the pathogen from our gardens we need adequate regulations covering nursery hygiene (Baker, 1977). ■

* Registered for use in control of blue mould on tobacco.

Studies on the Status of Unburnt *Eucalyptus* Woodland at Ocean Grove, Victoria

By JENNIFER R. WITHERS

Botany School, University of Melbourne, Parkville.

In the drier regions of Victoria it is rare to find vegetation which has remained unburnt for substantial periods of time. A remnant of such vegetation exists at Ocean Grove in Victoria, where a major fire has not occurred for at least 90 years.

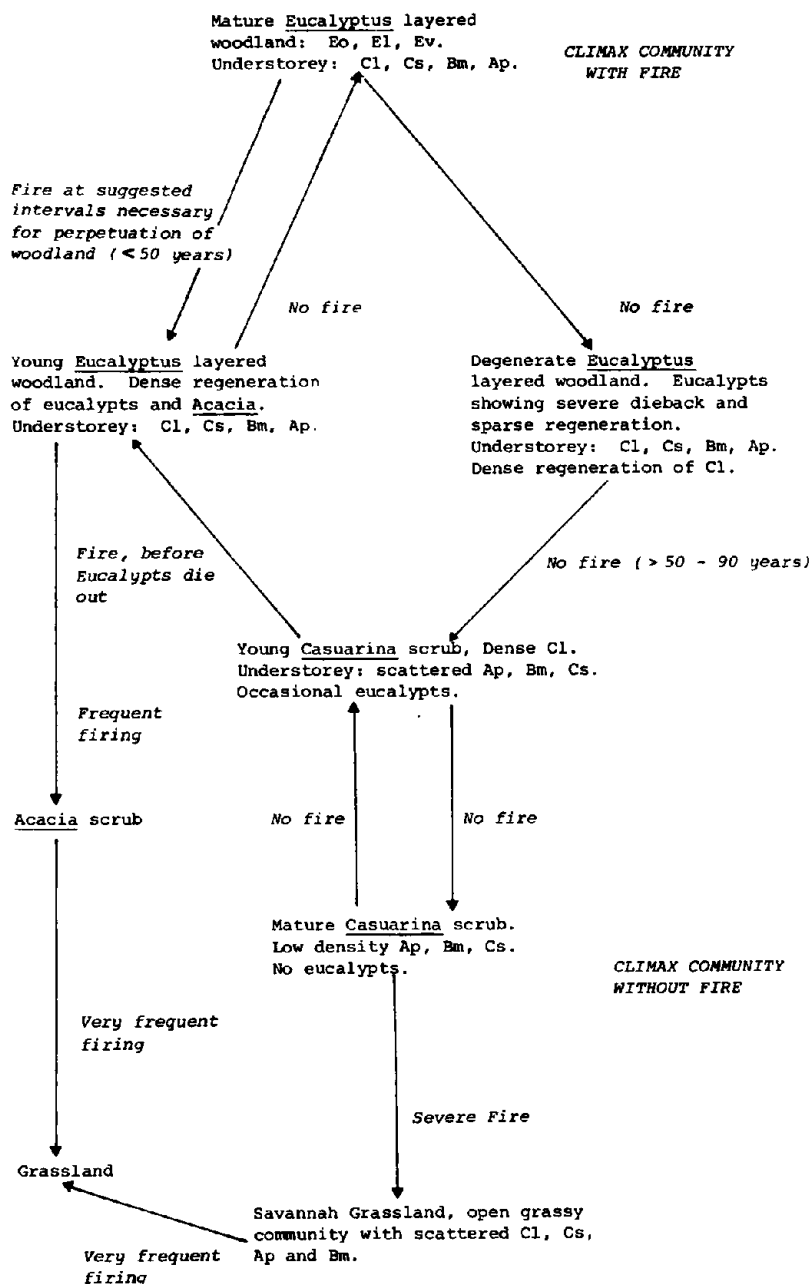
The Geelong district was cleared extensively in the late 19th and early 20th centuries, and by the 1930s the largest remaining area of natural bushland on the Bellarine Peninsula was "Cuthbertson's Square Mile", 2 km from Ocean Grove. This isolation from other forested areas may have contributed to its protection. Garnet (1961) reported that the "only interference with natural processes within the area, during the long, continuous ownership by the Cuthbertson family, was grazing by Cobb and Co. horses a very long time ago".

The vegetation comprises a mosaic of fairly mature *Eucalyptus* woodland and *Casuarina* scrub, which is clearly in a dynamic state. Evidence from regeneration patterns and local history indicates that the eucalypts are dying out and are being replaced by *Casuarina*. The layered woodland consists of an open upper storey of scattered *Eucalyptus ovata*, *E. leucoxylon* and/or *E. viminalis*, with a sparse to dense scrub understorey of *Casuarina littoralis*, *C. stricta*, *Acacia pycnantha* and *Banksia marginata*. The eucalypts are fairly large, with spreading crowns up to 12 m in width. In the woodland the ground stratum is mainly composed of dense *Themeda australis* and scattered sclerophyll shrubs, such as *Hibbertia sericea* and *Platylobium obtusangulum*.

The scrub is dominated by dense stands of *Casuarina littoralis*, although *C. stricta* and *Banksia marginata* are scattered or patchy. Vegetation is virtually absent in the thick litter layer of the denser stands of *C. littoralis*. The species composition of the ground stratum of gaps in the scrub canopy is, however, similar to that in the woodland, but the density of species is lower. *Acacia pycnantha* occurs in the scrub in various stages of maturity and senescence, or as young developing stands in large grassy gaps in the woodland. Dead eucalypts frequently overtop the *C. littoralis* stratum. Regeneration of eucalypts is virtually absent, while that of *C. littoralis* is relatively prolific. This observation evokes questions of the nature of the "climax" vegetation in the absence of fire and of the mechanism of replacement of *Eucalyptus* woodland by *Casuarina* scrub.

No correlations were apparent between the scales of vegetation pattern and soil pattern, viz. microtopography, depth to B horizon, soil texture and pH of topsoil. The simplest causal hypothesis appears to be related to the cycles of regeneration of the major tree species. Gaps in the scrub are due mainly to the death of eucalypts and/or wattles. The presence of old pioneer form *C. littoralis* and *C. stricta* in dense scrub testifies to the once more open nature of this stand. Dense thickets of *C. littoralis* around isolated dead or dying eucalypts suggest that either gaps have been vigorously colonised or perhaps dense regeneration of xerophytic scrub has irreversibly modified the environment of the eucalypts. The cause of death of eucalypts is uncertain. Tests for *Phytophthora cinnamomi* and *Armillaria mellea* have proved negative. Fruiting bodies of *Fomes* occur on some eucalypt trunks and occasionally on *Casuarina*; however, they are unlikely to be the primary cause of death. At present it is suggested that death may be partly due to water stress caused by the increase in *Casuarina* density. Thus patterning of the vegetation appears to be related to a long post-fire succession moving towards a climax or stable stand of *Casuarina*.

FIGURE 1



Suggested relationship between the occurrence of fire and the vegetation pattern at Ocean Grove under current environmental conditions.

KEY:

- Eo = *Eucalyptus ovata*
- El = *Eucalyptus leucoxylon*
- Ev = *Eucalyptus viminalis*
- Cl = *Casuarina littoralis*
- Cs = *Casuarina stricta*
- Bm = *Banksia marginata*
- Ap = *Acacia pycnantha*

The nature of the climax vegetation at Ocean Grove involves the question of establishment and regeneration of the major dominants. The stand has been isolated by farmland and protected from fire for at least 90 years. Ultimately the poor regeneration of the eucalypt woodland is almost certainly due to the absence of fire. Fire plays a major role in determining the nature and development of climax vegetation in Australia. Fire can stimulate germination and cause a temporary surge of soil fertility and relief from competitive factors. Optimum conditions for the establishment of eucalypt seedlings are often produced by severe wild fires. *C. littoralis* is an aggressive species which is vigorously invading *Eucalyptus* woodland and establishing a dense stratum. Since the *C. littoralis* scrub is self-regenerating, even in quite small gaps, it is considered to be a climax condition at the present time in the long-continued absence of fire. A suggested relationship between the occurrence of fire and the vegetation pattern at the study site under present environmental conditions is shown in Fig. 1. The frequency and intensity of firing, the time of the fire and the soil seed storage will obviously be important in assessing future vegetation patterns.

The mechanism of replacement of *Eucalyptus ovata* by *C. littoralis* appears to be related to the differential drought resistance and shade tolerance of seedlings of the two species. Due to the lack of fire at Ocean Grove, the grass sward is very dense, and seedlings encounter intense competition for light, moisture and space. Field and laboratory experiments have shown that *C. littoralis* seedlings can become established in the dense sward, whereas *E. ovata* cannot (Withers 1978a). Survival of *C. littoralis* appears to be due to the much greater drought resistance and shade tolerance of *C. littoralis* seedlings than of *E. ovata* seedlings (Withers 1978b, 1979a, 1979b). However, *E. ovata* seedlings were able to become established when the sward was removed by firing (Withers 1978a). After the field fire, *E. ovata* quickly dominated the experimental plot. It is considered that the dense stands of *C. littoralis* at Ocean Grove developed in the absence of fire, as preliminary studies suggest that *C. littoralis* is less fire resistant than *E. ovata*. Today regeneration of *E. ovata* beneath the dense *C. littoralis* canopy is inhibited by the lower light intensity and lower soil moisture content within such stands. Furthermore, powdered litter of *C. littoralis* inhibits the germination of seeds of *E. ovata* (Withers 1978a). With the long-continued absence of fire, it is hypothesised that a scrub of *C. littoralis* may become the climax vegetation in this dry climate. In the event of a major conflagration, it is considered that the climax will revert to a eucalypt woodland.

This tendency of the sclerophyllous understorey to dominate the site at the expense of the eucalypts is thus similar to the situation described in woodland at King's Park, Western Australia (Beard 1967), although the cause of the change appears to be different. The rare unburnt stands at Ocean Grove, therefore, provide a dry country analogue of the well-known encroachment of tall, open eucalypt forest by rainforest over so much of the wetter eastern seaboard of Australia (Gilbert 1959, Webb 1968).

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Recent Publications from the New South Wales National Herbarium - Summaries by R. Barry

TELOPEA Vol. 1, No. 5 (1978)

The fifth issue of "Telopea" from the New South Wales National Herbarium contains the following articles by members of Staff, unless indicated otherwise.

- Valerie May, Areas of Recurrence of Toxic Algae within Burrinjuck Dam.
New South Wales, Australia.
Valerie May, New Records for Australian Algae.
Alma T. Lee, Some Species of *Crotalaria* in Australia.
D. F. Blaxell, Notes on Australian Orchidaceae — a new combination in *Liparis*.
D. F. Blaxell, Type Specimens of Schlechter's Names in Orchidaceae at the
Conservatoire et jardin Botaniques, Geneva.
M. M. Hindmarsh (School of Botany, University of New South Wales) and
D. F. Blaxell, A new species of *Stylidium* (Stylidiaceae) from the Sydney Region.
M. D. Tindale, Notes on Australian Taxa of *Acacia* No. 5.
C. R. Carter (School of Biological Sciences, University of Sydney).
Taxonomy of the *Brachycome lineariloba* complex (Asteraceae).

Orchidaceae

The new combination *Liparis angustilabris* is made for a northern Queensland orchid. Due to an historical error this orchid had been known by the illegitimate name *Liparis cunellabris*.

The second paper on Orchidaceae lists specimens that were examined by Mr. D. Blaxell in Geneva. Many of these are isotypes and their status is designated. These specimens are important since the Holotypes of Schlechter's species were destroyed in Berlin in 1943. The list includes species of genera such as *Bulbophyllum*, *Cadetia*, *Dendrobium* and *Eria*.

Stylidium

A new species, *Stylidium productum*, is recognised and separated from *S. graminifolium* in which it was previously included. *S. productum* occurs only on soils derived from Hawkesbury and Narrabeen Sandstones of the Central Coast and Tablelands of New South Wales. One of the distinguishing features of the new species is that the leaves have stomata in two bands on the abaxial (under) surface only, while in *S. graminifolium* these bands are present on both abaxial and adaxial (upper) surfaces. Other differences in *S. productum* include stolons which produce new plants at intervals and a more restricted flowering period from November to the middle of January.

Acacia

Five new species of *Acacia* from eastern Australia are described. *Acacia pickardii*, a tree 3-4.5 m high occurs in the far northeast of South Australia and is known from a few plants only, along the Birdsville Track south to Mt. Gason. It appears to be allied to *A. teretifolia*.

Acacia ingramii, from the headwaters of the Macleay River on the northern Tablelands of New South Wales, is a very spreading bushy shrub 2-5 m high. It is allied to *A. neriifolia*.

Acacia guyeri, found in the Cook district of Queensland, is allied to *A. whitei*. It differs from the latter in its taller, open habit, the diffuse spikes, the paler yellow, widely spaced flowers, and the narrower phyllodes.

Acacia chinchillensis of Queensland is a multi-stemmed, spreading, glaucous shrub 0.3-2 m high with bright yellow flowers. It is closely allied to *A. polybotrya*.

Acacia debilis occurs in eastern and southern Queensland and northern New South Wales. It is a spindly shrub or small tree 2.5-6 m high with smooth greyish-green or reddish-green bark and golden-yellow flowers in racemes or panicles. It is closely allied to *A. pruinosa*.

Acacia phasmoides, from northeast Victoria, is now recorded from Dora Dora State Forest of N.S.W. and *A. blakei* known from Queensland, has been found in the far north coast and northern Tablelands of New South Wales.

Brachycome

The final paper presents a revised classification of the *Brachycome lineariloba* complex. Two new species are described. One of these, *B. dichromosomatica*, is notable in having a chromosome number of only 2 in the reproductive cells (the pollen and egg cell) and only 4 in most cells of the plant. Only a couple of other species of flowering plants (not ones native in Australia) have equally low chromosome numbers. Because of its unusually low chromosome number, which is reflected in its name, the genetics of this species and its allies is of special interest. The botanist who described these species has also made a detailed study of chromosomes in this group. Apart from chromosome numbers, the major differentiating characteristics are in the length and colour of ligule and the colour of the involucre bracts.

KEY TO THE BRACHYCOME LINEARILLOBA COMPLEX

1. Scapes erect, 30-250 mm long. Ligules 5-12 mm long, pale-blue or white. Margins of involucre bracts not usually pigmented, rarely reddish-purple.
B. dichromosomatica 2.
2. Ligules pale-blue, at least on the undersides var. *dichromosomatica* a.
- 2.* Ligules white var. *alba* b.
- 1.* Scapes decumbent to ascending, 1-200 mm long. Ligules up to 6 mm long, white. Margins of involucre bracts usually reddish-purple.
3. Scapes 1-20 mm long, first-formed scape less than 10 mm long. Ligules less than 1 mm long *B. brevicaulis* 3.
- 3.* Scapes 10-200 mm long, first-formed scape more than 10 mm long. Ligules 1-6 mm long *B. lineariloba* 1.

Crotalaria

In a review of the genus *Crotalaria*, large populations existing partly or wholly outside New South Wales had to be considered. The paper is divided into five sections, four of which deal with a particular complex or group of species. The *C. dissitiflora* complex comprises *C. benthamiana* from the Fortescue district of Western Australia, *C. dissitiflora* with subspecies *dissitiflora* and *rugosa* from tropical and subtropical Australia respectively, and *C. eremaea* with subspecies *eremaea* and *strehlowii*. The distinguishing characters of species in this complex are the trifoliate or unifoliate leaves, and the size of the flowers. The second complex comprises species from central and eastern Australia: *C. mitchellii* and its subspecies *laevis* and *smithiana*; here the distinguishing features are leaf and stem pubescence. The *C. novae-hollandiae* complex includes a number of subspecies and is found across northern Australia. The problems in the nomenclature of the fourth complex, *C. medicaginatae* and *C. trifoliatastrum* are discussed. The paper finally lists species of *Crotalaria* naturalised or escaped from cultivation in New South Wales. The Editor, Australian Plants, has extracted descriptions that may be of general use in the article opposite.

FLORA OF NEW SOUTH WALES, No. 112 (1978) — J. Thompson (National Herbarium of New South Wales).

Polygalaceae

The family Polygalaceae* comprises 18 genera and is represented in New South Wales by *Comesperma* and *Polygala* and by an African species of *Muraltia* that has naturalised to a limited extent. They are small trees, shrubs or herbs, occasionally parasitic on the roots of other plants. Descriptions and a key to the genera are given.

"Telopea" and "Flora of New South Wales" are not on sale but are available from the National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, 2000. Because of their technical nature, they are of value chiefly to those with a considerable degree of botanical expertise. Copies are available in municipal libraries in New South Wales and if, after perusing a copy, readers consider that either would be of interest and value to them, they may write to the Director of the Royal Botanic Gardens indicating their interest.

* Editors Note: Reports are needed from readers on the following Australian Polygalaceae.

Polygala: 12 Aust. species. *P. japonica* and *P. linariifolia* of N.S.W. are described with naturalised species.

Comesperma: Of the 25 Aust. species many are of interest, eight from N.S.W. are listed. *Salomia oblongifolia*, a slender glabrous annual with tiny pink flowers from Queensland. *Xanthophyllum*: Three species of tree from Qld., *X. fragrans*, *X. macintyrii* and *X. octandrum*.



Crotalaria dissitiflora

Photography by D. Hockings.

Crotalaria

Notes prepared by W. H. Payne from research,
by Alma T. Lee in *Telopea* 1(5) 1978.

Until recently, large and extensive populations of *Crotalaria* in Australia were covered by the name *C. dissitiflora* and other names were published

and sometimes used for parts of these regional populations. It is now evident that three parts of the total population maintain their distinctness to a high degree. Following descriptions of this group, two other complexes of species are defined involving *Crotalaria mitchellii* and a new species *C. smithiana*, and *C. novae-hollandiae* with two subspecies and including *C. crassipes*.

The *Crotalaria dissitiflora* Complex

It seems probable that *C. benthamiana*, *C. dissitiflora* and *C. eremaea* have evolved from a common stock, diverging under the influence of changing climatic and geographic conditions, and that the derivatives have become stabilised genetically in relation to the nature of the soil and to geographic isolation. *C. dissitiflora* occurs only on heavy, often dark soils, while *C. eremaea* (here including *C. strehlowii*) is nearly always found on sand.

1. Leaves always trifoliate, the lateral leaflets at least half as long as the terminal. Plants 20-30 (-40) cm high, on heavy soils.
2. Flowers large, 15-17 mm long, the keel with a straight beak extending forward and not incurved (Fig. 2). In the Fortescue District of Western Australia *C. benthamiana*
- 2.* Flowers smaller, mostly 8-11 mm long, the keel rounded with a slightly incurved beak (Fig. 1). In the Ord District of Western Australia, tropical Northern Territory and Queensland, and subtropical Queensland and New South Wales *C. dissitiflora*
- 1.* Leaves unifoliate, or if trifoliate the lateral leaflets usually much reduced or less than half as long as the terminal (but rarely, along S.A.-N.S.W. and -Q. borders and in W.A., about half as long as the terminal). Flowers various in form. Plants to c. 1 m high, on sandy soils. In eremian parts of southern Western Australia, Northern Territory, Queensland and New South Wales .. *C. eremaea*

Crotalaria benthamiana

Crotalaria benthamiana is a monotypic species limited to the Fortescue District of Western Australia where it appears to maintain its distinctness by complete geographic isolation. It is close to the subspecies *rugosa* of *C. dissitiflora* and like the whole of that species shows a preference for heavy soils.

It is a soft-wooded perennial, apparently identical in habit with *C. dissitiflora*, the leaves always trifoliate (except the earliest), petiolate and stipulate, the stipules usually persistent and spreading. *Leaflets* of thin texture but quite densely clothed with loosely appressed shining hairs partly obscuring the minute dotting of both surfaces; lateral leaflets at least half as long as long all elliptical/obovate to oblong.

Inflorescences terminal on stems and branches, as in *C. dissitiflora*. *Flowers* clear yellow without markings, larger than in the related taxa, long and "straight" (Fig. 2) in form. *Calyx* broadly campanulate, with five subequal teeth slightly exceeding the tube and the very short receptacle, pubescent, with a pair of very small bracteoles inserted on the receptacle. *Standard* broadovate to almost circular. *Wings* without a distinct auricle. *Keel* somewhat angular with the beak extended forward and not incurved, the claw very short. *Ovary* pubescent; fruits and seeds not seen.

Crotalaria dissitiflora

C. dissitiflora, comprises two geographic races. The subspecies *dissitiflora* is largely tropical, from the Ord District of Western Australia to Queensland, and subspecies *rugosa* is subtropical in Queensland and New South Wales. The former is distinguished from subsp. *rugosa* chiefly by the length and density of pubescence with a resultant appearance of the venation.

Soft-wooded perennials of small stature, usually less than 30 cm high, with a system of deeply sited and rather congested, ascending underground structures from which regeneration occurs after adverse climatic periods or disturbance such as ploughing. *Stems* several from the base, erect or decumbent, at first densely pubescent with loosely appressed silvery hairs becoming sparse and brownish with age. *Leaves* always trifoliate (after the primary, and perhaps also early leaves on regenerating stems), petiolate and stipulate; stipules linear, characteristically spreading, persistent on at least some leaves, but small and sometimes obscured, or fallen from old, dried specimens. *Leaflets* of rather thin texture, elliptical to ovate or obovate, the laterals at least half as long as the terminal, variously pubescent, the upper or both surfaces minutely dotted (when visible through the pubescence). *Inflorescences* terminal on stems and branches, racemes of about 10-20 flowers on axes usually a little longer than their peduncles. *Flowers* with rare exceptions, small and "round" (Fig. 1), clear golden yellow without other colouring or markings, pedicellate in the axils of small, finally recurved bracts. *Calyx* broadly campanulate, with five subequal teeth, the upper two usually a little shorter and narrower than the lower three, slightly exceeding the tube; tube slightly longer than and contracted into a short, basal receptacle; bracteoles minute, inserted usually near the top of the receptacle. *Standard* glabrous, nearly circular but slightly broader than long, scarcely auriculate, the calli extending on to the short claw, the apex shortly retuse or with a point in the indentation. *Wings* rounded-oblong to triangular, without a distinct auricle. *Keel* rounded, the beak slightly incurved. *Ovary* pubescent or hoary but some-

Fig 2

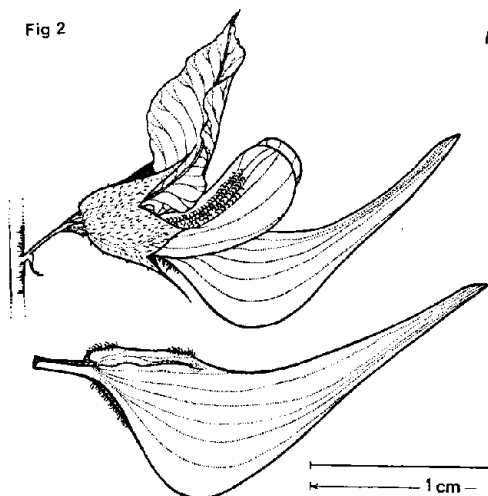


Fig 1

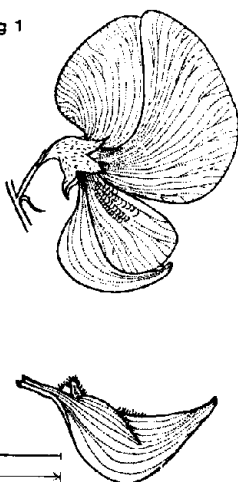


Fig. 1. An extreme example of the "small, round flower", and keel (from a different flower).

Fig. 2. An extreme example of the "long, straight flower", and its keel.

times apparently glabrous on the sides, with a more or less broad band of longer, rather coarse hairs along the upper suture, especially at its distal end. *Style* in a geniculate curve within the keel, bearded only on the inner side. *Pod* sparsely pubescent all over with short hairs outside, the sutural band now scarcely distinguishable, glabrous and shiny inside, oblong-clavate, tapered asymmetrically into a slender stipe. *Seeds* are yellow-ochre in colour with a marked but scarcely hooked radicular lobe the surface almost smooth.

Crotalaria eremaea

A soft wooded shrub to 1 m differing from the other species in this group in that there is usually a main stem that often arises from a horizontal, extensive underground "root" system. The leaves are thicker, at least by virtue of dense pubescence (thick mat of hairs) and the leaf surface where visible is minutely pitted or wrinkled rather than dotted. The leaflets are narrow-oblong to trullate with the laterals much reduced sometimes almost circular. The flowers may be "round" or straight 12-15 mm long.

A species of two races, the subspecies being: sub-species *eremaea* is found in the eastern and southern parts of the species range over central Australia in sandy soil. Sub-species *strehlowii* is found generally in the western area of the centre on sandhills, sandplains and near water courses. It differs from sub-species *eremaea* in leaf form being often single, trullate or ovate and nearly glabrous.

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Crotalaria verrucosa (below)

Photography by D. Hockings

Unique in the genus *Crotalaria* with mainly yellow flowers, *Crotalaria verrucosa* has flowers of the unusual colour shown below. It is a small shrub to one metre.

Crotalaria dissitiflora (top right)

Photography by D. Hockings

The flowers and leaves of this appealing shrub are shown in the colour plate on page 277, a full description being given on page 278.

Crotalaria eremaea (opposite on the left side)

Photography by D. Hockings

As described on page 279 this plant has a different growth habit, thrusting up a main stem to one metre high from an often extensive "root" system.

Crotalaria novae-hollandiae (opposite right)

Photography by D. Hockings

Terminal spikes of yellow flowers are a feature of this plant as described on page 282 with the spikes of flowers standing out above the grey-green foliage.

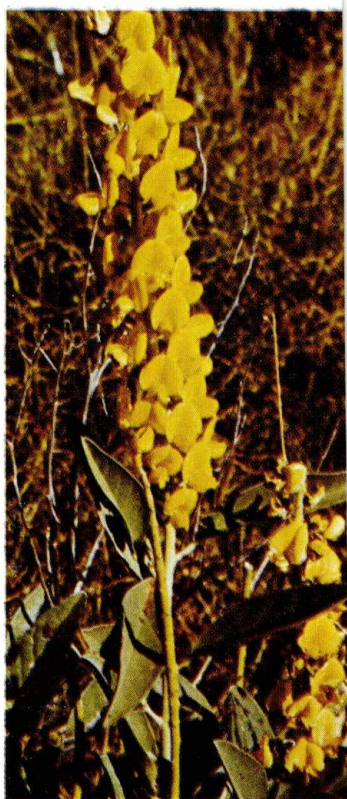




Crotalaria dissitiflora



Crotalaria eremaea



Crotalaria novae-hollandiae

Crotalaria mitchellii* and *C. smithiana

C. mitchellii comprises two geographical races, the subsp. *mitchellii* on coastal Queensland from the north to N.S.W. on sandy and light-textured soils frequently near streams or behind beaches, sometimes in open forest or weedy in rough pasture or cultivation, and subsp. *laevis* on the western slopes of the Great Dividing Range in southern Queensland and N.S.W.

Crotalaria mitchellii is a soft wooded erect or decumbent shrub about 0.5-1 m in height with glabrous or pubescent stems, the hairs rather short and ascending, and simple leaves. Leaves often elliptical or narrow-elliptical, glabrous and obscurely dotted above or sometimes on both sides and variously pubescent below, shortly petiolate to almost sessile with scarcely more than the pulvinus, with subulate to setaceous stipules; hairs of the pubescence from very short in subsp. *laevis* to softly curved and c. 1 mm long in subsp. *mitchellii*. Inflorescences terminal or leaf-opposed, racemes with numerous, crowded flowers. Flowers deep yellow, pedicellate and bracteate. Calyx with teeth subequal and slightly longer than the tube, the tube slightly protracted on the lower side, the receptacle scarcely discernible. Standard more or less circular but often slightly broader than long, with a pair of plate-like calli, or linear converging thickenings, at the base of the lamina. Wings rounded-oblong. Keel with a rounded, right-angled bend about the middle, the beak twisted at the apex. Ovary glabrous, almost sessile, the style geniculate but scarcely constricted at the bend, the pod oblong-clavate, tapered to the base, the stipe lengthening to equal the calyx tube. Seeds 8-12 in the pod, slightly flattened, somewhat glossy, greenish grey, with a hooked radicular lobe.

Crotalaria smithiana from central Australia, was previously known as *C. mitchellii* var. *tomentosa*. It is distinct from *C. mitchellii* in being a prostrate plant forming a cushion-like growth with densely spreading pubescent hairs on the stems whereas *C. mitchellii* has erect nearly glabrous branches with short up turned hairs. The leaves of *C. smithiana* are unifoliolate, the leaflet shortly petiolulate and articulate on a longer petiole, the joint sometimes obscure in the pubescence, tomentose on both sides at first, later more sparsely hairy to glabrous above, as distinct from the simple to almost sessile, glabrous and dotted above, glabrous or hoary to quite densely pubescent with possibly long hairs below of *C. mitchellii*.

***Crotalaria novae-hollandiae* (including *C. crassipes*)**

Research into Bentham's work on the above species and various forms has shown that all may be regarded as the one species with two geographic races, subsp. *novae-hollandiae* of tropical Australia being widespread in the monsoon belt, and subsp. *lasiophylla* of the dry areas of northern Australia below the monsoon belt. See colour plate on page 281.

Usually small shrubs to about 1.5 m in height, soft-wooded but probably perennial, with a more or less dense pubescence on some or most parts, or occasionally quite glabrous. Leaves unifoliolate, the petiole and usually shorter petiolule articulate and angled, stipulate with sometimes small and obscure or deciduous stipules; stipules always present on young stems but deciduous from the lower leaves, narrow, acuminate, erect then recurved, pubescent outside, glabrous within, often leaving a ridge, like that from the back of the petiole, decurrent on the stem (as described by Bentham for *C. crassipes*). Leaflets very variable in size and pubescence (see under the subspecies). Inflorescences terminal and leaf-opposed, the often numerous flowers somewhat variable in size and opening in basipetal or irregular order. Flowers yellow, often fairly large, on ascending then recurved pedicels and subtended by small, acuminate bracts similarly erect then recurved. Calyx broadly campanulate with the tube slightly protracted on the lower side, the teeth subequal, narrow deltoid and often slightly longer than the tube, the whole variously pubescent or occasionally quite glabrous. Standard more or less circular but often slightly broader than long with a pair of plate-like calli at its base not extending into the claw, the apex sometimes broadly pointed. Wings rounded oblong. Keel with a rounded right-angled bend at or slightly below the middle, slightly but constantly twisted at the apex, usually with a pair of shallow folds or pouches near the auricle. Ovary glabrous to partly or entirely pubescent, the style more or less geniculate but scarcely constricted at the bend. Pod clavate or somewhat truncate, tapered into a short stipe. Seed yellow ochre, with a marked radicular lobe.

1. Leaflets elliptical to ovate or narrower, tapered into the petiolule at the base variously pubescent but often with the upper surface less densely clothed than the lower and sometimes quite glabrous above or on both sides subsp. *novae-hollandiae*
- 1.* Leaflets triangular or with a more or less cordate base, not tapered into the petiolule, densely pubescent on both surfaces with a grey tomentum becoming golden to deep reddish brown with long drying subsp. *lasiophylla*

Microwave Treatment of Acacia Seed

WITH PARTICULAR REFERENCE TO ACACIA LONGIFOLIA

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INTRODUCTION

Acacias are well known for their hard seed coats, which necessitate some form of treatment if a satisfactory percentage germination is to be achieved. In general, Acacias are not considered "difficult" to germinate if a seed coat treatment is applied, in that the success rate is usually better than 80%, at least for small batches of seed. However, as the recent papers of Aveyard (1) and Clements et al (2) have shown, there is no one method which has a universally high level of effectiveness, and such factors as the species, age of seed, size of seed, time to harvest and other variables within a species can all contribute to erratic germination response. Acacias have found widespread application both in Australia and overseas for rapid regeneration of devastated land, as well as for large-scale landscape plantings. It appears that even for these applications the most popular method of seed coat treatment is a scaled-up version of that traditionally employed, i.e. boiling water is poured over the seeds, which are allowed to imbibe for up to 24 hours, after which the seeds are removed and planted. There are several disadvantages with this technique:

- (1) The number of seeds that can be effectively treated at any one time is limited.
- (2) The wet seeds are difficult to handle and should be dried before being mixed with sand or pelletised prior to hand broadcasting.
- (3) If the seeds dry out after treatment, e.g. due to lack of follow-up rains, a low percentage germination can result.

Some form of "dry" treatment which could process sizeable quantities of seed would obviously be advantageous. Scarification is one technique which is already widely used for reducing hard seededness in alfalfa and clover, and which has been applied to small lots of *Acacia* seeds (3). However, the process is expensive and is reported to cause considerable damage to the seed—it also dramatically reduces its keeping quality. In view of favourable overseas reports on the effectiveness of microwave heating in improving germination of alfalfa, clover and several species of pine, spruce and Douglas Fir, the method was evaluated for *Acacia longifolia*, a hardy and quick growing species widely used in Victoria and New South Wales.

2. EFFECT OF MICROWAVES ON SEEDS

Microwave energy is obtained from a magnetron oscillator. This contains a number of tuned circuits inside a vacuum envelope, and the energy produced is usually fed into a resonant cavity or chamber. The unit used for this work operated at a frequency of 2,450 MHz and had a measured power output of 650 watts.

Seeds, which were collected from the Lower Glenelg area in December, 1976, were exposed to the microwave energy in a foam polystyrene container for periods of time ranging from 60 to 240 seconds. For exposure times in excess of 160 seconds a beaker containing 50 cc of water was also placed in the cavity. This acts as a dummy water load and was used mainly to prevent overheating of the magnetron. After exposure the seeds were removed and their surface temperature was measured using a chromel alumel thermocouple. The seed coat was also examined using a Leitz Projection microscope.

At the above frequency, seeds like *Acacias* are relatively "transparent", i.e. the microwave energy can penetrate right through them. Seeds absorb energy by a mechanism known as dielectric heating, which is much faster than by conventional means. The energy is absorbed only by the seeds placed inside the cavity, and the amount of heat thus produced depends very much on the chemical composition of the seeds and to a large extent on their moisture content. It was assumed the moisture content of the test seeds was fairly constant—a typical value would be approximately 6-8%.

Seeds were germinated in soil or in egg boxes as described by Shiells (4). Ambient temperatures during the work ranged from 17°C to 30°C. Germination was assessed by the appearance of cotyledons above the soil or by the emergence of the radicle some 3 mm beyond the seed coat.

Figs. 1 and 2 show some of the results obtained. The percentage germination increased with longer exposure times (which corresponded with higher surface temperatures) for samples with and without the water load (Fig. 1). Some scatter was observed in the measured surface temperatures and it is not yet possible to predict with accuracy surface temperature for a given exposure time. However, for the batches of seed used the trend indicates that the higher the surface temperature, at least in the range 60°C-100°C, the better the germination.

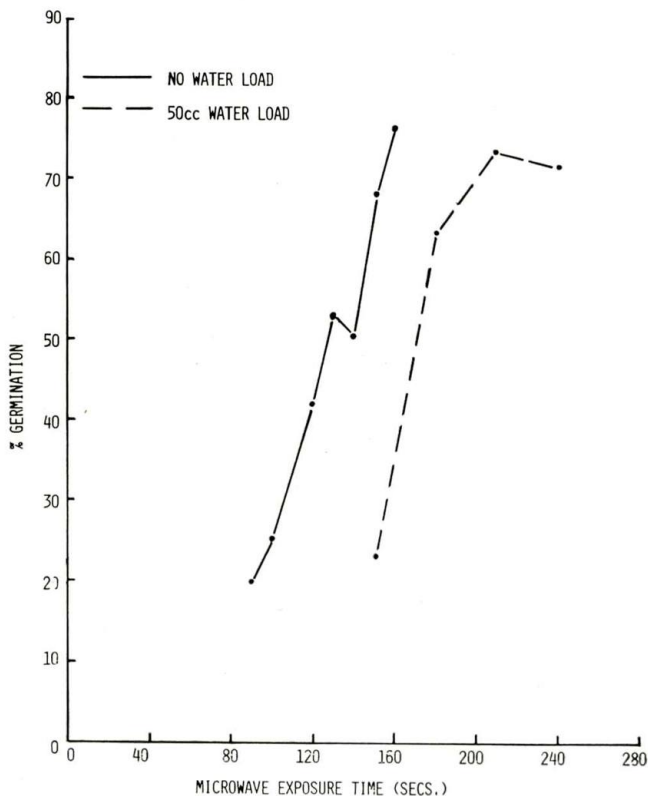


Fig. 1: Germination at three weeks as a function of microwave exposure time.

In Fig. 2 the progress of germination is shown for seeds treated in the presence of a 50 cc water load for time intervals 210 and 240 seconds and without a water load for 160 seconds. These results are compared with those recorded for seeds which were nicked or immersed in boiling water.

In general, both these last techniques show a faster rate of germination, and in the case of boiling water treatment a higher final percentage.

Seeds that had been nicked showed signs of rotting of the swollen seeds after about 12 days. However, observations at six weeks of seedlings from boiling water and microwave treatments revealed little apparent difference in seedling size and vigour. The microwave process also has an advantage in that the treated seed can be safely stored for periods of up to four weeks in paper envelopes with no apparent loss of viability. Nicked seeds in particular must be sown almost immediately if a satisfactory germination is to be obtained.

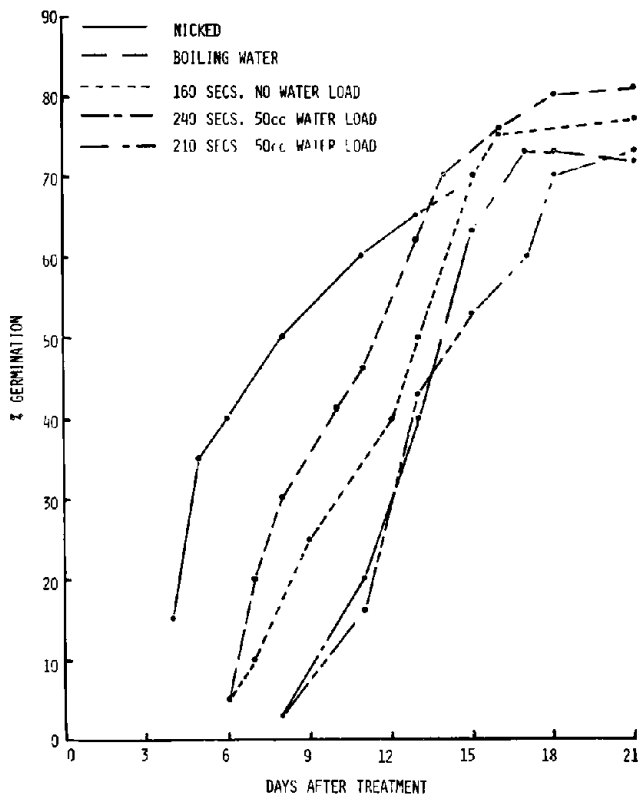


FIG. 2. PROGRESS OF GERMINATION FOR VARIOUS TREATMENTS

3. POSSIBLE REASONS FOR MICROWAVE EFFECTIVENESS

There is surprisingly little information available in the literature concerning the details of how *Acacia* seeds become permeable naturally, and even less discussion of the paths of water entry after seed coat treatment. For example, it is usually assumed that boiling water softens the seed coat, thus allowing water entry: this, however, has not been proven. Fire is often cited as the reason for *Acacia* regeneration in the wild. However, extensive regrowth has been observed in areas where fires have not occurred for many years, and as McIntyre (5) points out even 10 mm of soil will give adequate protection to seed from fire. He considers it is likely that other factors are operating. Preece (6) speculated that passage of seeds through the digestive tracts of birds might lead to seed coat breakdown. Other suggestions for natural permeability include damage due to wind and water movement over the ground (i.e. natural "impaction"), attack by micro-organisms in the soil and the

effect of diurnal temperature fluctuations. However, Preece (6) was not able to germinate *Acacia aneura* (mulga) by either impaction treatment or by duplicating temperature cycles for its natural environment for periods as long as 12 months. Observations of the seed coat under the microscope provided some insight into the manner in which microwave treated seed becomes permeable. Fig. 3 shows the appearance of the coat "as received" and after 240 seconds exposure. The cracks which developed were shown in cross-section to extend only approximately 40 μ m below the surface, i.e. to the second layer of the seed coat, while the whole seed coat is approximately 160 μ m thick. These cracks apparently play only a minor role in immediate water intake, but they can serve as a guide to expected germination behaviour, i.e. the more extensive the crack network, the higher the expected germination. The other effect noted was a change in the appearance of the strophiole, a raised, elliptical area on the surface near the hilum. Even today the role of the strophiole is unclear, but Ballard (7) has shown that for a number of species of legume subject to microwave treatment, the strophiole is the first site of water entry. In untreated *A. longifolia* seeds the strophiole is often indistinct, but after microwave exposure it appears golden and raised and is well defined under the microscope. Obviously the treatment has had some effect on the material in the strophiclar region. Whether this had any influence on water permeability was checked by the following experiment. Fifty seeds were exposed for 160 seconds, during which time they reached 90°C. The batch was split into two groups of 20 seeds and 10 were kept for microscopic examination. All showed extensive cracking and a raised, golden strophiole. In one set of 20 seeds the strophiole was covered with water repellent vaseline, while the other 20 were left "as is"—both lots were germinated under water. After two weeks 15 uncovered seeds had formed roots, while none of the vaseline-coated seeds had swelled. The evidence thus points strongly to the strophiole as being the dominant site of water entry in microwave treated *Acacia longifolia* seeds.

Using the same technique, we have also determined the initial site of water entry after boiling water treatment. The batch of treated seed was split into three groups—hilum covered, strophiole covered and seed uncovered.

Once again, the group with the strophiole covered did not swell, while the other two groups gave between 80% and 90% germination. Even though boiling water often roughens the seed coat, the damage does not extend beyond the cuticular layer, and general water intake through the seed coat does not occur to the same extent as through the strophiole.

4. CONCLUSION

In conclusion we have found microwave energy is an effective "dry" means of rendering *Acacia longifolia* seeds permeable. Times of 160 seconds without a water load and 210-240 seconds with a 50 cc water load were satisfactory and produced between 65% and 75% germination.

Will this treatment be successful with other types of seed and using a domestic microwave oven? We don't know until it has been tried out. At present I don't see why microwaves shouldn't work on any of the hard-coated legume-type seeds. Why not try it?

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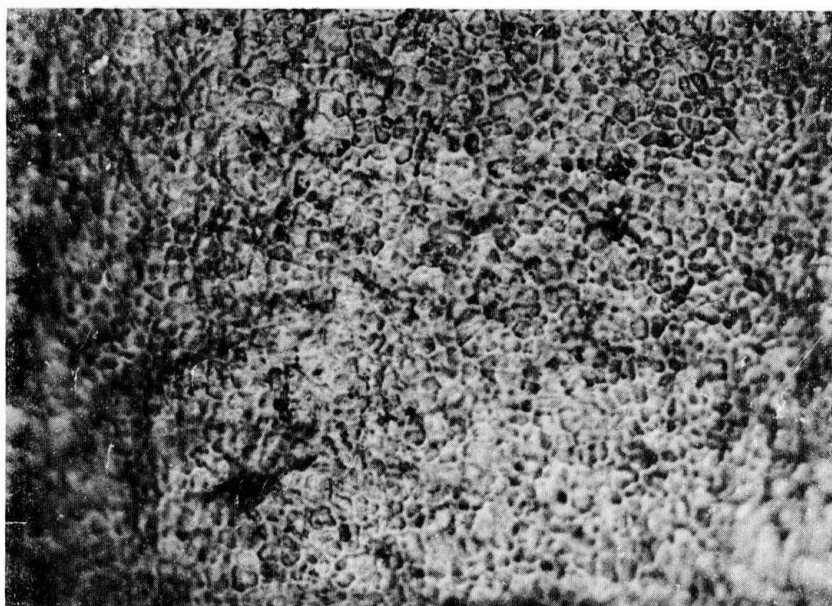


Fig. 3(a) *Acacia* seed coat, untreated x 200.



Fig. 3(b) Crack pattern developed after microwave exposure for 240 seconds x 250.



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Goodenia affinis

This is a prostrate plant rarely growing above 5cm. high that forms small clumps to 30cm. across. It is ideal for a rockery or undershrub near a garden border in a manner similar to many other herbaceous plants described on page 255 of this issue. They are difficult to photograph as the flowers appear as a double image. They grow to the size shown, the yellow being eye-catching against the silver-grey of the foliage. Other species of *Goodenia* recommended on page 258 have flowers similar to those shown above.

The Plant Family Goodeniaceae

Goodenia affinis belongs to the plant family Goodeniaceae. This family includes many exceptional groups of plants including *Lechenaultia*, *Scaevola* and *Dampiera* that are well known and prized as garden subjects. It also includes genera less well known and about which I am hoping readers will send reports and colour-slides. These genera are *Anthotium*, *Calogne*, *Calosperma*, *Coopernookia*, *Diaspasis*, *Neogoodenia*, *Nigremnia*, *Pentaptilon*, *Selliera*, *Symbiobasis*, *Velleia* and *Verreauxia*.