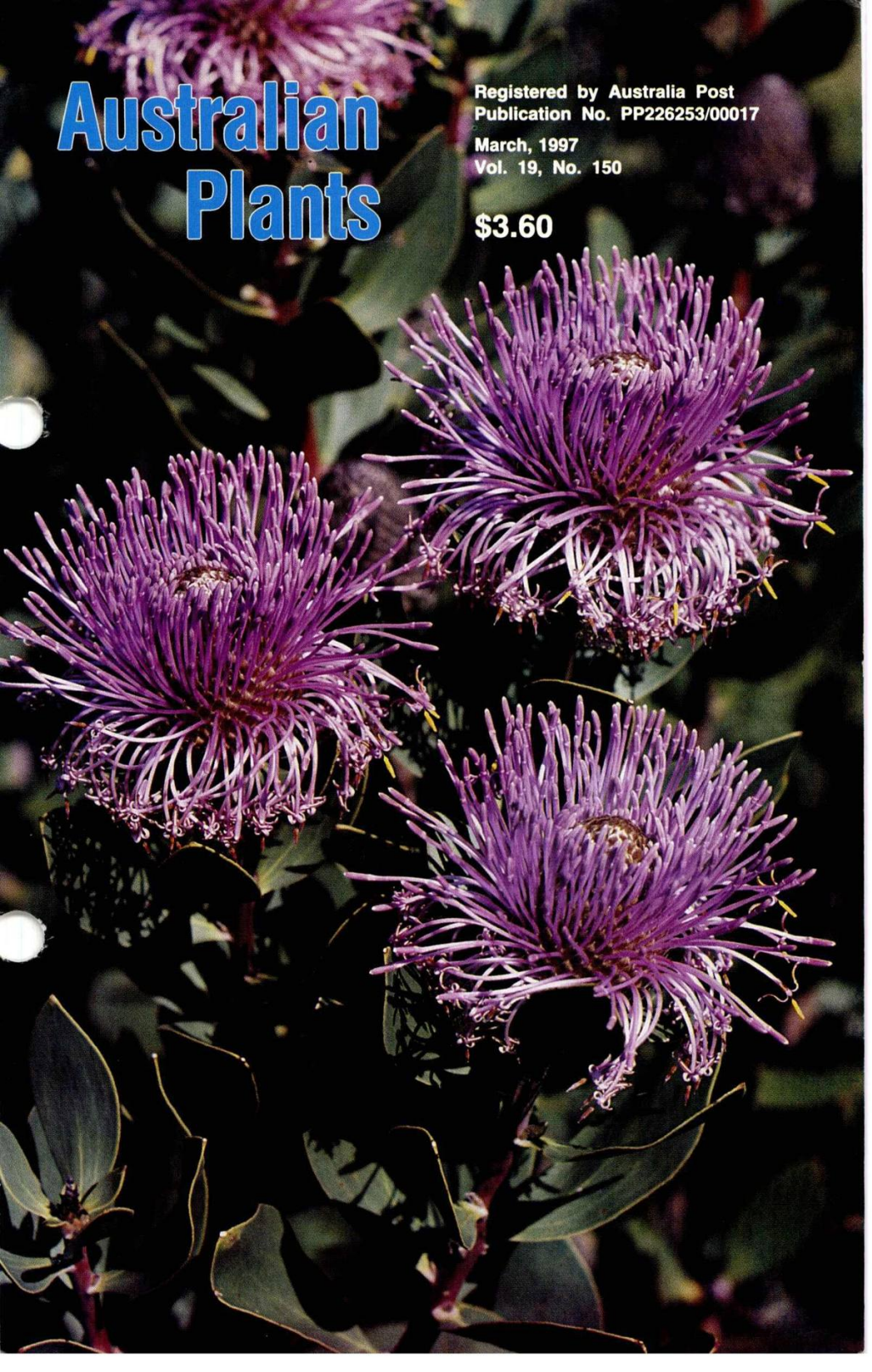


Australian Plants

The background of the cover is a photograph of three Australian plants, likely a species of Banksia. Each plant has a large, rounded, spiky flower head made of many thin, purple, needle-like petals. The leaves are dark green, elongated, and have a slightly waxy appearance. The plants are set against a dark, out-of-focus background.

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Australia Beyond 2001

With all the excitement and expenditure directed to the turn of the century and the years 2000/2001 we sincerely hope that our expectations for a prosperous, healthy continent beyond 2001 are taken seriously. The Chairman of the Centenary of Federation Council created to oversee the celebrations in 2001 of 100 years of federal government, has been appointed, Mr Dick Smith. His dedication to Australia's future, his commitment to the environment and his competence as a manager is widely known and I have every expectation that he will give me a fair hearing. The sectional pressures he will face will be extreme and his resources limited, but we hope these resources will be directed towards future prosperity rather than the glitter of the day or buildings of limited permanent value.

All Australians will want to be involved in the Year 2001, celebrations and sympathetic leadership can ensure this. All Australians are concerned for a prosperous future and there is a latent awareness that, for planet Earth, this depends upon the careful management of our natural resources. Pilot schemes have been implemented that will serve as a guide to future action and the training of experienced project leaders. One outstanding example is reported on our page 88. "Children and the Environment".

Green and Goldies, as suggested in our last issue? I expected some reaction from our "greenies", a concern that their efforts were not appreciated or even belittled. This has not been the case. Everyone is desperate for leadership in this area, the national spirit of comradeship to all work for the future of our land and sustained prosperity. Our commitment to conserve the natural environment, from the small but important natural reserve to the major issues effecting us all, has not wavered. We want everyone involved.

Stop, look at nature's wonders; the article opposite is a change of pace!

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COVER PLATE — *Isopogon latifolius* (photo by N. Marriott). A bushy shrub to 3 metres tall but grown as a cut-flower crop as shown on page 68 it can be less than 2 metres. See page 74 for a description. Together with *Isopogon cuneatus* on our rear cover, given a well drained soil and plenty of sunshine this unique plant has potential as a cut flower in the cooler or inland areas.

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Flower colour change in the Proteaceae

by Byron Lamont, School of Environmental Biology, Curtin University, GPO Box U1987, Perth, WA 6001

One of the joys of a native garden is to be able to witness nature at work. The reward for one's curiosity and careful observations is the exhilaration from making your own discoveries about how plants relate to their environment and an admiration for the tricks that they perform. While on study leave in the Cape of South Africa in 1980, I gradually realised that some proteas, such as *Leucospermum oleifolium*, had red and yellow flower heads on the same plant. Further examination showed that the young heads were yellow and turned red after a few days. Later again, the flowers turned brown and withered in the usual way; it was noted, only the yellow phase possessed pollen and nectar.

Watching the honey bees, they only visited the yellow heads to collect nectar but ignored the red ones. They had clearly learned to associate colour (not that they see them as the same colours as humans) with reward. This presumably had advantages for the bee, as it did not waste energy visiting rewardless flowers. It presumably had advantages for the plant, as desirable pollen was not wasted on already fertilised or non-receptive flowers.

Then why not just let old petals and styles, or old flowers that did not get fertilised, drop off? I reasoned that retention of old flowers in a colourful condition probably served to enhance the overall attractiveness of the plant to pollinators from a distance. Once close to the plant they would use the different colours as a cue to which flower heads to visit for nectar.

On returning to Australia, I was keen to see if the same phenomenon occurred here. I was not disappointed. I visited the Crystal Brook public open space on the Darling Scarp, 15 km east of Perth. Many species, mainly in the Myrtaceae and Proteaceae, showed flower colour change. I studied eight species in earnest over three seasons and the results were published in the Botanical Journal of the Linnean Society in 1985. On the Swan Coastal Plain near my home, I noticed that the flower heads of the Holly-leaved Banksia, *Banksia ilicifolia*, also changed from yellow to red. This species was very different to the others that I had studied (it was a substantial tree, rather than a shrub, and it was pollinated by birds, rather than just insects. The results were published in the Australian Journal of Ecology in 1988. My co-author, a zoologist, showed that the New Holland Honeyeater soon learned to visit either the yellow or red heads, depending on which ones had honey water added to them (after removing nectar from the yellow heads).

In these studies, most of my time was spent counting the number of flowers of each colour (including transitional ones) on replicate plants, and counting the visits each colour phase received from birds and insects (sometimes through binoculars). I have maintained a hobby interest in the topic since then. In 1990, I was contacted by a Californian, Martha Weiss, who was undertaking her doctorate on flower colour change, especially in relation to visits of butterflies on lantanas. From literature reading, thumbing through wildflower books and our own observations, we have now recorded over 450 species worldwide in 78 families that show flower colour change. There are many more, watch for them.



△ *Banksia illicifolia*, the plant habit
 ▽ *Petrophile biloba*, the plant habit



△ *Banksia illicifolia*, a young flower head
 ▽ an older flower head turned red



▽ *Petrophile biloba*, flower heads
 note the yellow and red knobs





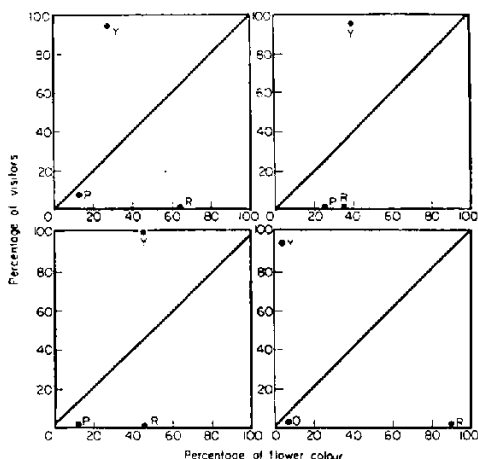
△ *Grevillea pilulifera*, the plant habit
▽ closeup of yellow and red knobbed flowers



△ *Isopogon dubius*, a closeup of the yellow and red knobs of the flower, plant top left
▽ *Grevillea annulifera*, flower colour change



So far, we have recognised flower colour change in 41 species of Australian and South African Proteaceae. This is second only to the Myrtaceae, with 49 species, having most species on a world scale. It seems that the world centre of flower colour change could well be the woody shrub flora of south-western Australia. I believe the reason for this is the enormous displays of spring flowers from hundreds of co-occurring species which give the generalist pollinators a huge choice of what flowers to actually visit. Those species which can make the pollinator-fertilization relationship most efficient will have a competitive edge.



Percentage of insect and bird visitors seeking pollen or nectar from each flower colour phase plotted against the percentage of flowers of each colour on the plants.

Upper left: *Banksia ilicifolia*;
 Upper right: *Grevillea pilulifera*;
 Lower left: *Isopogon dubius*;
 Lower right: *Petrophile biloba*.

The diagonal line represents random choice of flower colour by the visitors. Points above the line show that colour is favoured while points below the line show that colour is discriminated against. Y = yellow, P = pink, O = orange, R = red.

Isopogon, with 13 species, is second only to lupins (18 species) among the largest genera with flower colour change on a world basis. Other well represented genera among the Proteaceae are *Grevillea*, *Hakea* and *Petrophile*. *B. ilicifolia* is the only known example among banksias, although its close but rare relatives, *B. cuneata* and *B. oligantha*, should be checked. Of course, other banksias show impressive colour changes, such as *B. menziesii*, but this is from the unopened flower bud to the open flower condition (this is not usually recognised as flower change) the flowers have to change once they are open. There is no doubt that this phenomenon also directs pollinators to the most rewarding flowers, which are in the transition zone between the two colours (the so-called "opening front"). Sometimes all flowers in the inflorescence change colour at the same time — usually those that occur as a cluster, like *B. ilicifolia* or *Hakea petiolaris*. In these cases, the whole flower usually changes colour, such as *Hakea laurina* whose style changes from cream to pink, and perianth and flower stalk from pink to cerise. In others, only part of the flower undergoes a colour change. Examples mostly come from species which only offer pollinators a pollen reward — all isopogons and petrophiles, and a few grevilleas, such as the rare *G. drummondii*. Either the swelling at the tip of the style (known as a pollen presenter as that is what it does) or the swelling beneath the pollen presenter (both may serve as landing knobs — the insect clings to the swelling and brushes pollen piled around the stigma onto its abdomen) change from yellow to orange-pink or red. The rest of the flower remains unchanged.

Species	Colour change	Part that changes
<i>Banksia ilicifolia</i>	Yellow to red	whole flower
<i>Grevillea drummondii</i>	Yellow to red	pollen presenter
<i>Grevillea floribunda</i>	Yellow-green to orange	perianth
<i>Grevillea leptobotrys</i>	Deep pink to pale pink	perianth
<i>Grevillea miniata</i>	Dark green to orange	margin of split perianth
<i>Grevillea olivacea</i>	Red to black	inner perianth
<i>Grevillea pilulifera</i>	Yellow to red	pollen presenter (landing knob)
<i>Grevillea prostrata</i>	Cream to red	style
<i>Hakea adnata</i>	Cream to pink	style, perianth
<i>Hakea cinerea</i>	Pale yellow to orange	perianth style/perianth, pedicel
<i>Hakea laurina</i>	Yellow to pink/ pink to cerise	style, perianth
<i>Hakea lissocarpa</i>	White to pink	pollen presenter, perianth
<i>Hakea petiolaris</i>	Cream to pink	landing knob (beneath presenter)
<i>Isopogon adenanthoides</i>	Yellow to red	landing knob
<i>Isopogon asper</i>	Yellow to red	landing knob
<i>Isopogon cuneatus</i>	Yellow to red	landing knob
<i>Isopogon divergens</i>	Yellow to red	landing knob
<i>Isopogon dubius</i>	Yellow to red	landing knob
<i>Isopogon inconspicuus</i>	Yellow to red	landing knob
<i>Isopogon formosus</i>	Yellow to red	landing knob
<i>Isopogon latifolius</i>	Yellow to red	landing knob
<i>Isopogon linearis</i>	Yellow to red	landing knob
<i>Isopogon scabriusculus</i>	Yellow to red	landing knob
<i>Isopogon teretifolius</i>	Yellow to red	landing knob
<i>Isopogon dawsonii</i>	Yellow to red	landing knob
<i>Isopogon tridens</i>	Yellow to red	landing knob
<i>Isopogon aff. crithmifolius</i>	Yellow to red	landing knob
<i>Petrophile biloba</i>	Yellow to red	landing knob
<i>Petrophile diversifolia</i>	Yellow to red	landing knob
<i>Petrophile linearis</i>	Yellow to red	landing knob
<i>Petrophile megalostigma</i>	Yellow to red	landing knob
<i>Petrophile rigida</i>	Yellow to orange-brown	landing knob
<i>Petrophile serruriae</i>	Yellow to red	landing knob

In species which provide abundant nectar, either the whole flower changes or only the style or inside of the perianth darken with age. All these changes serve to direct the pollinator to young flowers requiring removal of pollen or receipt of non-self pollen. An interesting twist are the species which present their pollen at the tip of the style as the reward for pollinators. Usually the entire lump of pollen is removed on the first visit. But the stigma is rarely mature at this stage, so pollinators must be induced back to the flower to bring non-self pollen when it no longer has any reward to offer. The bees hover in front of each flower presumably trying to detect if pollen is present as well as if it is the "right" colour. They are easily deceived, as my studies showed that half the visits were to rewardless yellow phase flowers. Perhaps the fact that both the landing knob and pollen are yellow at this stage aids the deception? More remains to be discovered about the fascinating topic of flower colour change in the Australian flora. ■

Editors note: Flower colour change can be an important factor in the cut-flower trade. Many flowers are more appealing because of the unique blobs of colour in the centre and certain clones may be selected because of this feature for breeding on to meet market demand.



△ *Boronia heterophylla* colour forms

Boronia purdieana ▽



Boronia

Its commercial cultivation

Julie A. Plummer* and W. H. Payne
from an article by Julie Plummer published
in *Native Australian Plants, Horticulture and Uses***

Boronia at present in commercial production include the following species. These notes are based upon the Western Australian species (the first four plants described below) as these have been the subject of greatest study and are, at present, the most intensively cultivated for commercial return.

Boronia megastigma, Brown or Sweet-scented *Boronia*.

William Chandler was the first grower to cultivate *Boronia megastigma* commercially for cut flowers, and from 1800 he sold cut flowers at the Victoria Market. It became such a thriving industry in the Basin district that the town of Boronia was named in honour of it in 1920. The establishment of an industry based on its essential oils took longer to start but has been the most successful boronia enterprise.

Distillation of the *Boronia megastigma* flower to extract essential oils began in 1925 and for over 40 years was solely from flowers harvested from the bush. In 1993 the quota from bush picking was set at 7,000 kg of blossom for oil production and 100 kg for cut flowers.

Commercial planting in Tasmania began in 1950 and Essential Oils of Tasmania has been extracting oils from extensive cultivated stands ever since.

Boronia megastigma will tolerate warmer climate but a period of cool conditions is always required for the setting of flowers. Plants grow naturally in a pH of 3.5 to 6.5, the preferred level for cultivation being 5–5.5 in a well drained slightly acid soil, preferably a peaty sand.

Boronia heterophylla is fast growing, responds well to pruning and produces a dense bush. It withstands heavy frost down to -8°C with no damage and in New Zealand it survives snow fall. It will grow in a range of soils and will tolerate permanently moist but not waterlogged soils. Plants will grow best in dappled shade or partial shade but will also grow in full sun if the roots are kept moist. The flowering period is short, about 2 weeks and flowers fade if left on the bush. Some selections registered include 'Lipstick' (mid-pink), 'Moonglow' (white) and 'Cameo' (pale pink)

Boronia molloyae produces similar bell-like flowers to *B. heterophylla* but they do not fade, with a colourful display from October to January. It is a more upright shrub with soft hairy pinnate leaves. The cut flowers have a limited post harvest life and are not grown commercially yet.

Boronia purdieana is a dwarf shrub to 60 cm with densely hairy and finely divided light green leaves to 1.2 cm long. It bears a profusion of highly perfumed, greenish-yellow flowers from July to August. Being early flowering, it is highly sought after as a cut flower. In 1993 a total of 49,260 bush-harvested stems and 898 stems from cultivated plants were exported.

*Julie Plummer is a Senior Lecturer in Horticultural Science at the University of Western Australia with research interests in the reproductive biology of commercial fruits and flowers and seed physiology of Australian Plants.

***Native Australian Plants, Horticulture and Uses* is a new book as advised on page 59.

Boronia muelleri occurs naturally on the southern coast of NSW and Victoria. It varies from a dwarf shrub to a small tree with sweetly scented green to bronze pinnate leaves, 5 cm long. A profusion of white to pale-pink flowers, 1.5 cm across are borne in terminal clusters from August to November. One selection 'Sunset Serenade' is a small dense shrub.

Boronia pinnata is a small shrub from NSW bearing clusters of pink flowers from August to November. It is in high demand as a cut flower by florists. The vase life is 5–8 days.

Boronia serrulata, Native Rose, is a small understorey shrub to 1.5 m tall producing abundant rose-pink flowers from July to November. A vegetative flush occurs from December to January and in cultivation can produce 20–25 cm stems for cut flowers.

***Boronia* as a commercial crop.** In 1993 there were 32,190 plants of boronia in cultivation around Australia. It is estimated that there will be 47,000 by now.

Planting of *Boronia* as a field crop

A well drained slightly acid soil is required, preferably a peaty sand. A pH of 5–5.5 is recommended but 3.5 to 6.5 has been successful. Plants should be ready to plant in winter/spring and should not to be root bound in the pot. Wind damage can to be avoided by providing windbreaks. Plants are often arranged in double rows with spacing from 0.5–1 metre between plants in a row, and 0.5–1 metre between the rows spaced at 1–4 metre centers. This will provide a plant density of 2,500 to 11,520 per hectare.

They are shallow rooted, producing a mat-like system in the top 30 cm of soil. Root disturbance should be avoided and the soil kept moist; waterlogging will enhance the risk of damage from rootrot and collar rot fungi. They are also susceptible to root-knot and root lesion nematodes, particularly in areas with summer rainfall.

In areas with distinctly seasonal rainfall such as southern Western Australia, provide irrigation and organic mulching during dry periods. In WA young plants require 2 litres/plant/day and mature plants up to 10 litres/plant/day. Micro-irrigation supplied several times during the day is preferable because of the poor water holding capacity of sandy soils and the shallow root system. Irrigation from October (after flower cropping) to April is essential to ensure adequate extension growth for the next season, for cut flower production of *Boronia heterophylla*.

Scientific studies that provide guidance to growers.

Plants do not wilt if water is reduced but a healthy looking plant may suddenly die. The provision of shade may alter the flowering period and increase the abundance of flowers and oil yield. Fertiliser with an N:P:K ratio of 4.5:0.3:2.5 has been shown to be suitable. A higher level of nitrogen early in the growing season (October) gives the highest yield of flowers while similar applications before this, that is during the bud development stage, reduce yield. Under field conditions and after flowering, supply NH_4NO_2 , and $\text{Ca}(\text{NO}_3)_2$. They are generally superior forms of N (nitrogen) to urea or slow release IBDU. High levels of N promote vegetative growth at the expense of flowering but if applied before flower development this is not the case. For maximum yield in the field, 50 kg per hectare of N should be applied as $\text{Ca}(\text{NO}_3)_2$ or NH_4NO_2 in two applications to reduce loss due to leaching by rain.

Fertigation of commercial plantings of *Boronia heterophylla* in Perth commences in November (after harvest) and continues until March to encourage as much extension growth as possible before flower initiation.

Boronias propagated from cuttings or tissue culture will flower in 12–15 months after planting but will yield only 8–12 stems per plant. Harvest in the second year can yield 20–30 stems and in the third and fourth year 30–60 stems. Commercial plant life is usually 5–6 years for *Boronia heterophylla* and longer for *Boronia megastigma*. Flowering stems of *Boronia heterophylla* are harvested when most of the flowers on a stem are partially open or at least 50% in full bloom for the cut stem market. Flower buds will not open after harvest. Mature plants are usually pruned to a height of 25–25 cm at harvest with some horizontal laterals left intact.

Clean straight stems of *Boronia heterophylla* greater than 60 cm long, with 50–70% blooms open and no wilting, are regarded as first grade fresh cut flowers by the Floral Export Council of Australia. Second grade stems are of 40–60 cm long. They have been exported to Japan for 7 years and other markets are growing. A major obstacle is the limited flowering season and colour range. Research at the University of Western Australia is addressing these issues. ■

Native Australian Plants

Horticulture and Uses

by Krystyna Johnson and Margaret Burchett

Primarily intended as a source book and manual for tertiary teachers and students of horticulture, and for professional growers, this book has much wider appeal. It is a record of scientific and applied field research into the commercial cropping of *Ptilotus* (Mulla Mullas), *Banksia*, *Macadamia*, *Persoonia*, *Telopea* (Waratah), *Pimelea*, *Acacia*, Sturt Desert Pea, *Baeckea*, *Chamelacium* (Wax Flowers), *Eucalyptus*, *Thryptomene*, *Micromyrtus*, *Scholtzia*, *Boronia*, *Actinotus* (Flannel Flower), *Lechenaultia*, Native Daisies, *Anigozanthos* (Kangaroo Paw), *Blandfordia* and *Caustis*.

The article above on *Boronia* is a brief report on a chapter in the book. As the studies are based upon basic scientific research followed by applied field trials, the authors refer to the specific research giving the parameters of how it was carried out and the conclusions reached. The large volume of supporting scientific data and analysis is not included. Readers want to know how and why a study was carried out and how it may be specifically applied to their needs and this book does just this for the commercially cultivated species nominated above.

Published by the University of NSW Press this book is available widely for \$69.95 or by mail as directed inside our rear cover. There is much to be learnt by all those who grow Australian plants either for pleasure, profit, or conservation.

Seriously contemplating the commercial cropping of wildflowers?

After reading this book contact the Department of Agriculture in your state for more specific details and advice on how to proceed. There are also seminar weekends regularly held in most states where commercial growers meet and listen to reports on the latest research, cultivation practices, harvesting and marketing, and exchange experiences. In NSW there will be a weekend at Batemans Bay in March and at Wagga Wagga in June, the latter to cover the Riverina area of the Murray and Murrumbidgee Rivers and also the western slopes of the Dividing Range north to Emerald in Queensland.

Hairy root clusters

Why are they so abundant in the most nutrient-impoveryished soils in Australia?

by Byron Lamont, Curtin University, Western Australia

Root clusters were first recognised in the large Australian family, Proteaceae, where they were given the name of proteoid roots. Proteoid roots consist of clusters of longitudinal rows of extremely hairy rootlets. All but a few primitive members of this family of about 1,800 species are now considered to produce them, including those in South Africa and South America. Hairy root clusters have also been identified as an important component of the root systems of many other Australian plants including species in nine genera of peas (Fabaceae), one *Acacia* (Mimosaceae) and some casuarinas (Casuarinaceae). These root clusters are not as tightly packed as proteoid roots.

Related root clusters have been recognised in many sedges (Cyperaceae). Their rootlets are swollen, carrot-shaped (dauciform) with obvious gaps between them but they appear even hairier than proteoid roots. Another sedge-like family, the Restionaceae, has surface rootlets similar to dauciform roots but they are not swollen. The grass-tree, *Kingia australis* (Dasypogonaceae) has concealed aerial roots whose root clusters proliferate among the persistent leaf-bases.

This article demonstrates that these root clusters exploit nutrients in the humus and decomposing litter layers and provide an adaptive advantage in nutrient-impoveryished soils on which litter accumulates.

Soil profile distribution

Root clusters are distributed where organic matter levels are greatest. In one study using *Hakea laurina*, while roots were absent from the raw litter, proteoid roots accounted for over 80% of the roots in the decomposing litter (A_0 horizon), followed by the humus layer (A_1) and were absent from the depositional layers (B). The compound proteoid roots (groups of clusters) of the important genera, *Banksia* and *Dryandra*, in scrub-heath and woodland are so dense that they form a continuous mat, 20–50 mm wide, enmeshed among the litter and humus particles. A similar pattern exists for other proteaceae and root cluster types.

By shifting the position of the organically-rich layer through the profile it was shown that there is a causal relationship in *Hakea laurina*. A_1 soil placed at a depth of 240–360 mm resulted in 227 proteoid roots per gram of root, whereas normally there would only be 8. This could be due to the well-established effect of local nutrient enrichment but it may occur even in the absence of a substantial increase in general root growth. A more likely cause is the effect of the abundant soil bacteria. In a way still not understood, these stimulate the production of proteoid roots. The causal organisms do not invade the roots and mycorrhizal fungi are not normally present. Aerobic conditions at the surface may be important in favouring root cluster production, especially in waterlogged soils.

Editor's note: This article is of particular significance, not only to growers of plants in Australia, but for the stabilisation of our soils. Its relevance to land conservation is defined in "Living With Australian Soils", page 87. Do not confuse "hairy root clusters" with proteoid roots where a mutually beneficial mycorrhizal, fungal association is involved, see "Proteoid Roots" by Byron Lamont, *Australian Plants*, Volume 18, page 345. Species with root clusters are rarely mycorrhizal (though legumes are still nodulated) which implies they both have a similar function.

Inorganic nutrient effects

If root clusters enhance nutrient uptake as a response to poor soils they should also form preferentially in those soils. Provided base levels of other nutrients are sufficiently low, as the external supply of nitrogen or phosphorus is increased from nil, the contribution of proteoid and dauciform roots to the plant rises from zero, peaking well before total plant growth is at a maximum. Root cluster production may even fall away to zero again once total root, and then shoot, growth peak. At higher base levels of other nutrients, proteoid roots may be present only in the absence of nitrogen or phosphorus. This indicates that they are optional components of the root system, dependent on the nutritional status of the soil or plant. Thus seedlings grown in fertile soils (high in clay or humus) may attain maximum shoot size but they may lack proteoid roots. In *Banksia ericifolia*, proteoid roots are eliminated once leaf phosphorus reaches 0.5% of its dry weight.

Function of root clusters

Root clusters have a superior capacity over unmodified roots for absorption of nutrients from the soil surface horizons. Early work showed that uptake of phosphorus from solution by proteoid roots may be up to 13 times greater than by unclustered roots. The aerial root clusters of *Kingia* readily absorb phosphorus inserted among the dead leaf bases with a hypodermic needle. Calculations show the surface area to weight ratio of root clusters may be up to 25 times that of the parent root. More importantly, the clusters may explore 32.5 times the volume of soil as an equivalent weight of parent root. In addition, root clusters have a strong reducing, acidifying and chelating capacity for poorly-soluble sources of phosphorus, iron and manganese. Secreted citrate appears to have a central role in enhanced iron and phosphorus uptake. These effects can be attributed to the greater surface area and compaction of root clusters which raise the concentration of exudates in the rhizosphere. Further, uptake is facilitated by adhesion of the long, abundant root hairs to soil particles and the presence of copious mucilage. The recent evidence of enhanced enzyme activity by proteoid roots even indicates a possible role in organic matter decomposition.

Soil nutrient levels

It is now necessary to show that species with root clusters are best represented in the most impoverished soils and that the most fertile part of these soils is in the organically-rich surface horizons. For the non-arid parts of Australia, the least fertile soils are the deeply leached, acid sands, sandstones and laterites widespread in southern Australia. Agricultural crops require the addition of P, N, K, S and trace elements (Cu, Zn, Mn, Mo) to these soils. There is increasing evidence that some of these soils, especially in south-western Australia, may be among the world's least fertile. It is here that species with root clusters have their centres of distribution. This is especially so for the Proteaceae, restios and sclerophyllous legumes which are concentrated in the poorest sands and laterites of south-western Australia. Given adequate moisture, these soils are sub-optimal for growth of species normally restricted to them. It is in these soils that most nutrients arise from the decomposing litter, so that their concentration is greatest at the soil surface. P is more likely to be an exception. Although it is stored in, and released from, the litter and humus, it is reabsorbed in the B horizon. The dead leaf bases of *Kingia* are a much better source of nutrients than the soil in which it grows. *Continued on page 78.*

Editors note: The conclusions to this article are presented on page 78 with due apologies to the author. They are of particular importance to conservation of our land as mentioned on page 88.

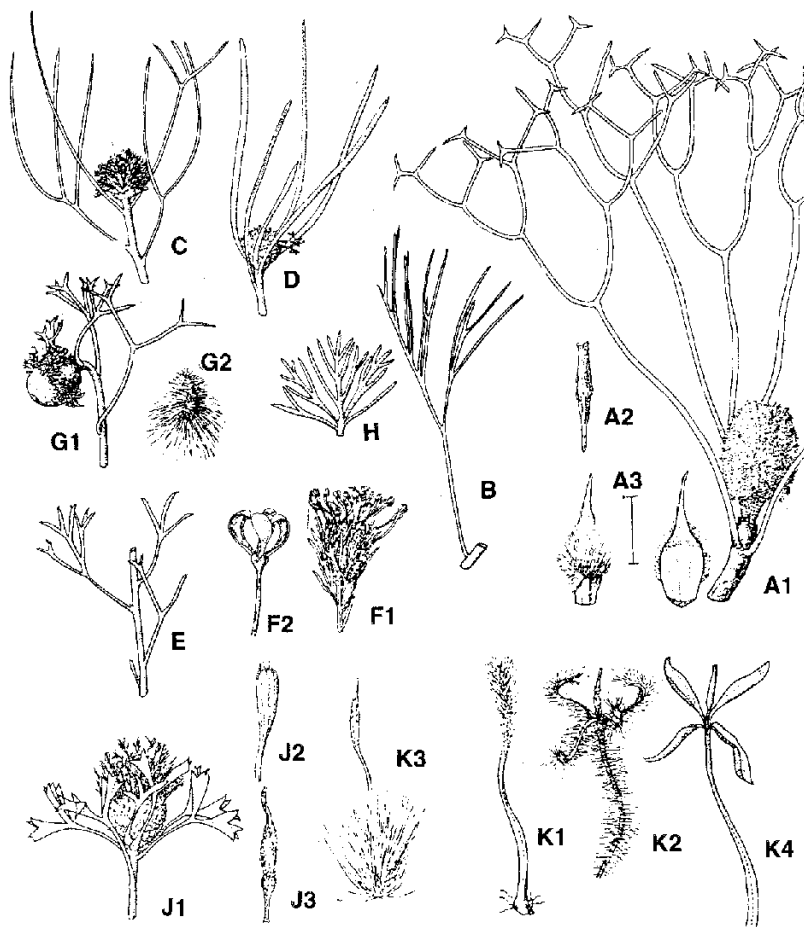


Figure 1 — *Isopogon* with cylindrical (round in cross-section) or terete leaves.

Those species with flat leaves such as in figure J below are illustrated in figures 2 and 3.

- A. *Isopogon villosus*, A1 a flowering branchlet; A2 the pollen presenter, A3 a cone scale.
- B. *Isopogon anethifolius*, a leaf.
- C. *Isopogon divergens*, a flowering branch, the flower terminal on the branch.
- D. *Isopogon scabriusculus*, a flowering branch.
- E. *Isopogon heterophyllus*, a flowering branch, see the photograph on page 69.
- F. *Isopogon adenanthoides*, F1 flowering branchlet, F2 a flower.
- G. *Isopogon teretifolius*, G1 a flowering branchlet, G2 a nut enclosing a seed.
- H. *Isopogon asper*, a leaf, pinnate with some segments further divided.

Characteristics of *Isopogon* flower and fruits as described opposite.

- J. *Isopogon dubius* with flat divided leaves shown here to illustrate the following features:

J1, the flower head differing from the flower in G where the head is drooping.

J2, a flower bud yet to open and J3, a pollen presenter.

- K. K1, a flower bud yet to open, K2, a flower that has opened to display the four hairy tepals and the central pollen presenter which is a modified style.
- K3, a flower with the tepals removed. The pollen presenter is surrounded by a tuft of hairs.
- K4, a dehiscent flower.

Isopogon, Drumsticks

The genus

all species described by D. B. Foreman*

In Australia there is a great concentration of proteaceous plants found nowhere else in the world and this includes the group known as *Isopogon*. One obvious centre for Proteaceae development is the south-west corner of Western Australia where there has been a great deal of speciation of hardy shrubs on the sandy and lateritic soils that dominate the area. It is in the heathlands and shrublands of this region that both *Isopogon* and the closely related genus *Petrophile* have reached their greatest expansion. Other species confined to the eastern states are a familiar sight in the bush.

Isopogon refers to the tufts of hair at the tip of the tepals (petals) of some species or possibly the hairs which cover the nut. They are mostly shrubs or rarely small trees with rigid, simple or divided leaves which maybe rounded in cross-section (terete), see figures 1, or flattened and sometimes broad as in figures 2-3. The individual flowers are clustered together in tight heads and are often referred as "cones" because of their superficial resemblance to pine cones. Hence also the common name "Coneflowers".

Unlike better known genera in the same plant family such as *Grevillea* and *Banksia*, the individual flowers of *Isopogon* (and *Petrophile*) occur singly rather than in pairs. At the base of each flower there is a bract-like structure usually referred to as a cone scale. The individual flowers are grouped in a "ball-like" head of flowers as shown opposite.

The flowers have no stalk, are straight, vary in colour from pink to mauve to yellow, cream or white and have four petal-like segments called tepals. Both male and female parts are present, with the pollen being shed before the female parts become receptive thus acting as a mechanism to encourage cross-pollination. The end of the style is modified in various ways and acts as a pollen presenter as is the case for many Proteaceae. The branchlets are mostly reddish brown or sometimes greyish and are often covered with short soft hairs when young. In *Isopogon* the cone scales do not persist or become woody and fall away when small, hairy egg-shaped nuts are released.

Little is known about the pollination and seed dispersal mechanisms in either *Petrophile* or *Isopogon* and any observations would be welcomed by the author especially if accompanied by photographs.

Plants of *Isopogon* (and *Petrophile*) are killed by fire but a number of species have well developed lignotubers. These lignotubers sprout prolifically after fire to form thick multi-stemmed clumps. Often information on just how many species have lignotubers is patchy and further observations are welcomed.

*Based upon *Flora of Australia*, Volume 16, a CSIRO publication. Available as directed inside our rear cover for \$64.95. Permission to use this valuable scientific publication as a source for presentation in a way more easily read by those without a knowledge of botanical terms is appreciated by all. Readers are advised that, with a little perseverance, they can use the original work quite well and they are urged to purchase a copy of each volume in which they are interested, prices on application by mail to the address inside our rear cover. The author is Dr D. B. Foreman is from the Royal Botanic Gardens, Melbourne. The sketches are by Mr P. Cooper of Ballarat, Victoria and are reproduced with permission and sincere thanks.

Many people, including professional botanists, have difficulty distinguishing between *Isopogon* and *Petrophile* and misidentification often occurs. The most reliable way of recognising *Isopogon* is by the fruits which are always hairy, egg-shaped nuts, usually less than 5 mm long, with a more or less persistent beak at the apex. In *Petrophile* the nuts are often flattened, sometimes winged and completely glabrous or with the hairs more or less restricted to the edges of the fruit. The cone scales in *Isopogon* never become woody or persistent and fall away when the nuts are shed. In most *Petrophile* the old cones persist for a year or so after the nuts have been released. The development of the pollen presenters in both genera is normally somewhat different except for a small number of species in both genera where the end of the style end is simply slightly swollen.

A guide to *Isopogon* based on readily observed features

Leaves terete (round in cross-section)

Flowers creamy yellow or yellow

Leaves pinnate or bipinnate (see figure 1B) *I. anethifolius*

Leaves divaricately divided (see figure 1A) *I. villosus*, *I. gardneri*

Flowers dirty white tinged with pink, creamy pink, reddish purple or mauve *I. asper*,

I. adenanthoides, *I. formosus*, *I. heterophyllus*, *I. divergens*, *I. scabrisculus*,
I. inconspicuus, *I. teretifolius*

Leaves flat or slight concave (hollowed), leaf blades undivided, margins entire

Flowers pink to mauve to purplish pink

Cones axillary (figure 2A) *I. axillaris*

Cones terminal, solitary (figure 2C) *I. cuneatus*, *I. latifolius*

Cones in clusters towards the end of branches (figure 2E) *I. linearis*, *I. buxifolius*

Flowers white, creamy white, greenish, creamy yellow, yellow or creamy green

Flowers glabrous *I. polyccephalus*, *I. fletcheri*

Flowers silky *I. uncinatus*, *I. buxifolius*, *I. longifolius*, *I. attenuatus*,
I. sphaerocephalus

Leaves flat or slightly concave, variously divided or lobed as in figure 3.

Flowers white, silvery white, creamy white, pale grey, pink or purple *I. dawsonii*,

I. dubius, *I. baxteri*, *I. tridens*, *I. crithmifolius*, *I. alcornis*, *I. scabrisculus*

Flowers creamy yellow or yellow

Flowers glabrous except for a tuft of hairs at the tip of each tepal or glabrous at the
base and becoming villous towards the apex *I. mnoraifolius*,

I. anemonifolius, *I. petioiaria*, *I. prostratus*, *I. ceratophyllus*

Flowers uniformly silky-villous or silky pubescent *I. alcornis*, *I. trilobus*,
I. longifolius

Isopogon adenanthoides (figure 1F, photo page 72) is a small shrub to 1 m tall. The leaves are deeply three lobed or simple, petiole where distinct to 8 mm long, leaf-blade terete, villous, to 18 mm long, tips needle-like. Cones are terminal, sessile, to 45 mm in diameter in flower, 15 mm diameter in fruit. Flowers are pink, to 25 mm long, glabrous except for a tuft of hairs on the tip of each tepal, appearing from July to October. It is restricted to a small area north of Perth from Three Springs to Badgingarra, growing in shrubland or heath on laterite.

Isopogon alcornis is a low shrub to 45 cm tall. The leaves are divided into 2–5 broad lobes, rarely simple, petiole at least 15 cm long, leaf-blade flattened, up to 40 cm long, tips sharp. The cones are terminal, sessile, often near to ground-level, to 40 mm diameter in flower, to 25 mm diameter in fruit. Flowers are white or pink, to 20 mm long, silky, appearing from October to November. Restricted to an area around Esperance and Mt. Baring in Western Australia where the species grows in low shrubland on sandy soils.



△ *Isopogon anemonifolius*

Photograph by R. Reinschmidt

Isopogon anethifolius ▽

Photograph by J. Simmons



Isopogon anemonifolius (figure 3R, photograph on page 65) is a shrub to 2 m tall. The leaves vary from being undivided to 2–3 lobed to almost pinnate with no petiole, leaf-blade flattened, 5–11 cm long terminating in a sharp or prickly point. Cones are terminal or sometimes axillary, sessile, to 40 mm diameter in flower, to 25 mm diameter in fruit. Flowers are yellow to 14 mm long, glabrous except for a tuft of hairs at the tip of each tepal, appearing from July to December. Common along the coast and nearby tablelands of NSW in heath or sclerophyll woodland forest on sandy soils.

Isopogon anethifolius (figure 1B, photograph on page 65) is an erect bushy shrub to 2 m tall. The leaves are pinnate or bipinnate, petiole to 5.5 cm long, leaf-blade terete, to 10.5 cm long, tips sharp. Cones are terminal or axillary, sessile or with a short stalk, to 40 mm diameter in flower, to 25 mm diameter in fruit. Flowers are yellow, to 12 mm long, shortly silky, from September to November. It grows in dry sclerophyll forest and heathland on the central and south coast and tablelands of NSW on sandstone.

Isopogon asper (figure 1H) is a low shrub usually less than 1 m tall. The leaves are pinnate, with some segments further divided, petiole to 13 mm long, leaf-blades to 20 mm long, tips sharp. Cones are terminal or on short axillary branchlets, densely clustered towards the end of the main branchlets, sessile, to 40 mm diameter in flower, to 20 mm diameter in fruit. Flowers are pink, 18 mm long and glabrous. It is found mainly on the Darling Scarp in Western Australia growing in open heath mostly on laterite or granite soils.

Isopogon attenuatus is a shrub to 1.5 m tall, often sprouting from a lignotuber. The leaves are undivided, with a petiole to 5 cm long, leaf-blade narrowed towards the base, flattened, thick, to 16 cm long, glabrous, tip rounded and ending in a sharp or hooked point. Cones are terminal or in upper leaf axils, sessile, to 50 mm diameter in flower, 25 mm in fruit. Flowers are creamy yellow to pale yellow, to 15 mm long, villous towards the tips of the tepals, appearing from September to November. It grows in open sclerophyll woodland on laterite, from near Perth around to Albany in Western Australia.

Isopogon axillaris is a shrub to one metre tall. The leaves are divided with no distinct petiole. The leaf-blades are narrow, flattened, thick, 12 cm long, tips rounded ending with a short very sharp point. The cones are axillary, sessile, 35 mm long in flower, 10 mm diameter in fruit. The flowers are pale pink to purplish pink, to 35 mm long, covered with long hairs towards the tips, appearing from July to October. It is found in coastal and near coastal areas in the south-west corner of Western Australia in seasonally wet, sandy places.

Isopogon baxteri (figure 3O) is an erect shrub to 1.5 m tall. The leaves are villous when immature, wedge shaped, often three lobed, petiole 6 mm long, leaf-blade flattened, margins wavy, to 5.5 cm long, lobes variously toothed, each tooth ending in a needle-like point. Cones are terminal, sessile, sometimes clustered together, 35 mm diameter in flower, 27 mm diameter in fruit. Flowers are pink, 35 mm long, greyish villous, appearing August to January. It is restricted to the Stirling Range and Mt Barker in Western Australia where it grows in heath or shrubland on laterite.

Isopogon buxifolius (complex) (figure 2A) consists of shrubs up to 1.7 m tall. The leaves are undivided, with or without a distinct petiole, leaf-blade flat or slightly hollowed, to 35 mm long, tips rounded and ending in a sharp, straight or curved point.

The cones are spike-like, terminal or clustered towards the end of the branchlets on short lateral shoots, often concealed by the leaves. The flowers are pink, mauve, creamy white or white, glabrous except for a tuft of hairs on the tip of each tepal, from May to December. It occurs on shrublands and heathlands, sometimes in swampy areas, on sandy soils or laterites in south-west of WA.

Isopogon ceratophyllus (figure 3T) is a prickly shrub up to 1 m tall. The leaves are highly divided, petiole 1.2–5.6 cm long, leaf-blade flattened, to 3.6 cm long, tips needle-like. Cones are terminal or axillary, sessile, surrounded by leaves, to 30 mm diameter in flower, to 20 mm diameter in fruit. The flowers are yellow, 15 mm long, glabrous except for a tuft of hairs on the tip of each tepal, appearing between July and Jan. Found, on sandy soils in heathland forest or woodland in south-west Victoria the south-east corner of SA and on the Bass Strait Islands.

Isopogon crithmifolius is a shrub to 1.3 m tall. The leaves are highly divided, petiole up to 25 mm long, leaf-blade flat to 40 cm long, tips sharp. The cones are terminal, sessile to 35 mm diameter in flower, 20 mm in fruit. The flowers are reddish pink, 30 mm long, glabrous except for a tuft of hairs at the tip of each tepal, appearing in September and October. It grows in eucalypt forest or shrubland on laterite from near Perth south-east to near Cranbrook in WA.

Isopogon cuneatus (figure 2B, photograph on page 96) is a bushy shrub to 2.5 m tall. The leaves are undivided, without a distinct petiole, leaf-blade flattened, broadest just above the middle, thick, to 10 cm long, tips rounded ending in a short hard point. Cones are terminal and very conspicuous, to 55 mm diameter in flower, 35 mm in fruit. Flowers are pale pink to purplish pink, 25 mm long, glabrous except for a tuft of hairs at the tip of each tepal, appearing from July to October. It is common in heathland or shrubland or low woodland on laterite around Albany and the Stirling Range and extending slightly eastwards.

Isopogon dawsonei (figure 3M) is an erect shrub or small tree to 5 m tall. The leaves are pinnate or simple, petiole to 7 cm long, leaf-blade flattened, to 11.5 cm long, tips with a sharp point. Cones are terminal, sessile, to 45 mm diameter in flower, to 25 mm diameter in fruit. The flowers are silvery white, creamy white, grey white, to 16 mm long, densely silky-villous, appearing from August to October. It is restricted but locally common to the central western slopes and central tablelands of NSW in sclerophyll forest or sandstone.

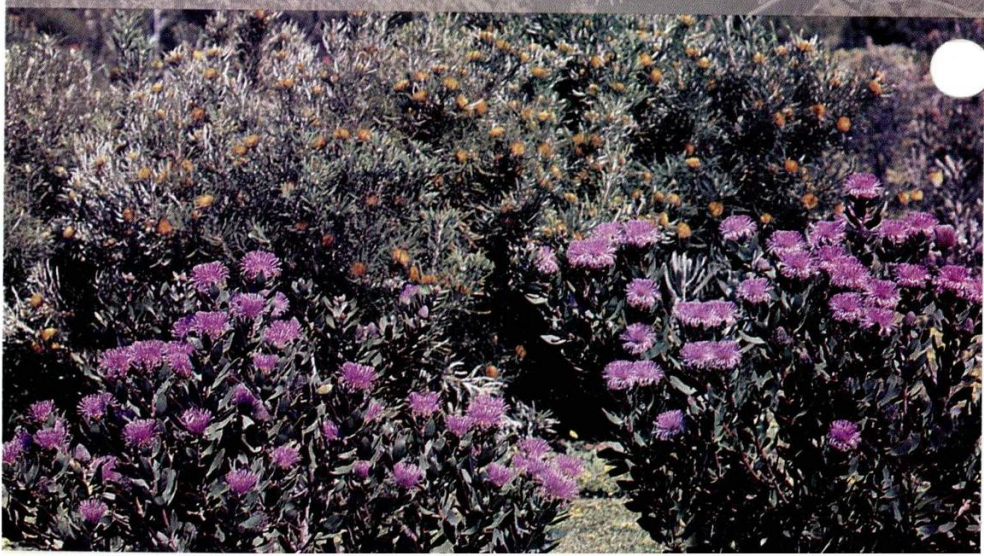
Isopogon divergens (figure 1C, photograph on page 73) is a shrub mostly to 1.5 m tall. The leaves are mostly pinnate or sometimes simple, petiole, where distinct, to 5.6 cm long, leaf-blade sand-papery to touch (scabrous), terete, to 10.5 cm long, tips needle-like. Cones are terminal, sessile, to 45 mm diameter in flower, fruit barrel shaped, to 18 mm diameter. Flowers are pink, 2.5 mm long, glabrous except for a tuft of hairs at the tip of each tepal, appearing from August to October. It is widely distributed in the northern part of south-west Western Australia in shrubland or heath, on gravelly, sandy or granitic soils.

Isopogon dubius (figure 3N, photo page 53) is a shrub to 1.2 m tall. The leaves often are deeply three lobed or pinnate, the petiole 2 cm long, the blade flattened, folded to form a deep groove or channel, the tips curved backwardly with a needle-like point. The cones are terminal or in upper leaf axils, conspicuous, to 50 mm diameter in flower, 30 mm in fruit. The flowers are pink to reddish, to 30 mm long, glabrous except for a tuft of hairs at the tip of each tepal, from July to September. In open woodland or heath on sand or laterite it is confined to the Darling Ranges in WA.



△ *Isopogon heterophyllus*
 Photograph by R. Gibbons

Isopogon latifolius as cut flower ▽
 Photograph by N. Marriott





△ *Isopogon heterophyllus*
 Photograph by Ivan Holliday

Isopogon drummondii ▽
 Photograph by D. Foreman



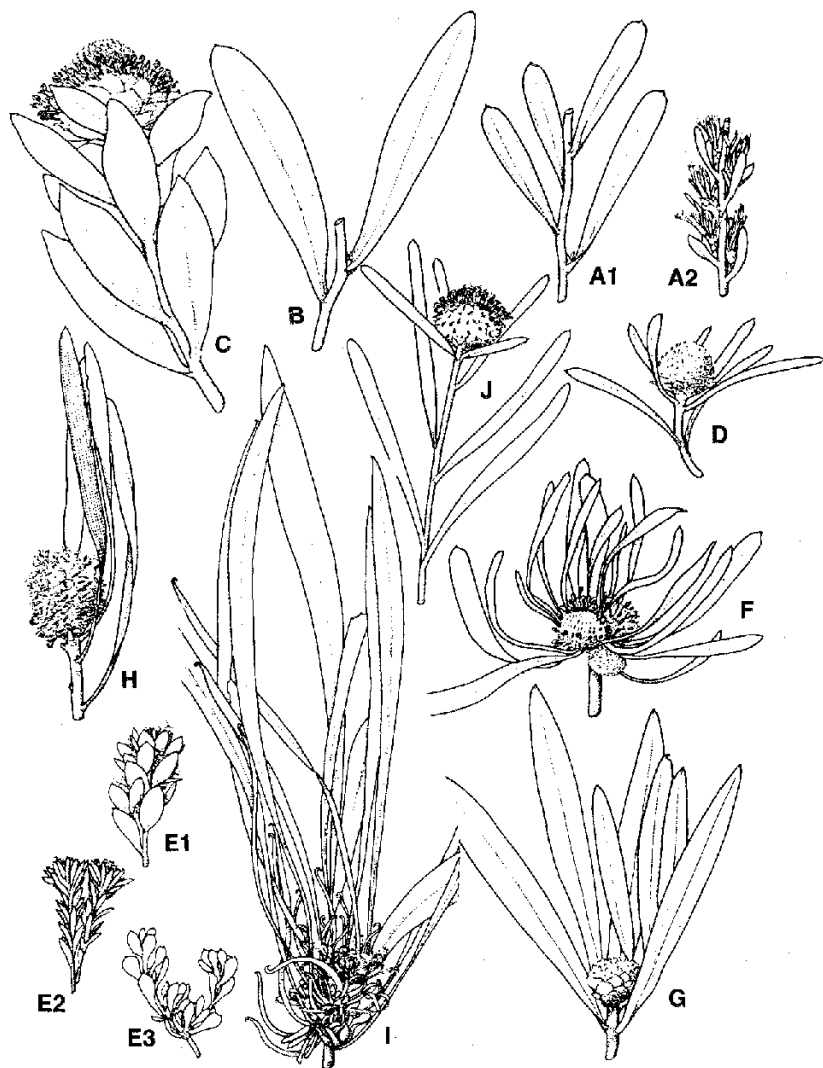


Figure 2 — *Isopogon* with flat or slightly concave (hollowed) leaf blades, with undivided or entire margins.

- A. *Isopogon axillaris*, A1 leaves, A2 flowering stem. Flowers and cones axillary (in leaf axils).
 B. *Isopogon cuneatus*, the leaves. Flowers and cones will be solitary on the ends of branches.
 C. *Isopogon latifolius*, a flowering stem. Flowers and cones will be solitary on the ends of branches.
 D. *Isopogon linearis*, a flower. Flowers and cones are in clusters towards the ends of branches.
 E. *Isopogon buxifolius*, flowering branchlets. Flowers and cones will be solitary on the ends of branches. As the leaf shape shows, E1 is variety *obovalus*, E2 is variety *linearis* and E3 is *spathulatus*.
 F. *Isopogon polycephalus*, flowering branch, multi headed. Flowers without hairs (glabrous).
 G. *Isopogon fletcheri*, a fruiting branchlet. Flowers without hairs (glabrous).
 H. *Isopogon longifolius*, a flowering branchlet. The flowers will be silky.
 I. *Isopogon uncinatus*, a flowering branchlet. The flowers will be silky.
 J. *Isopogon sphaerocephalus*, a flowering branchlet. The flowers will be silky.

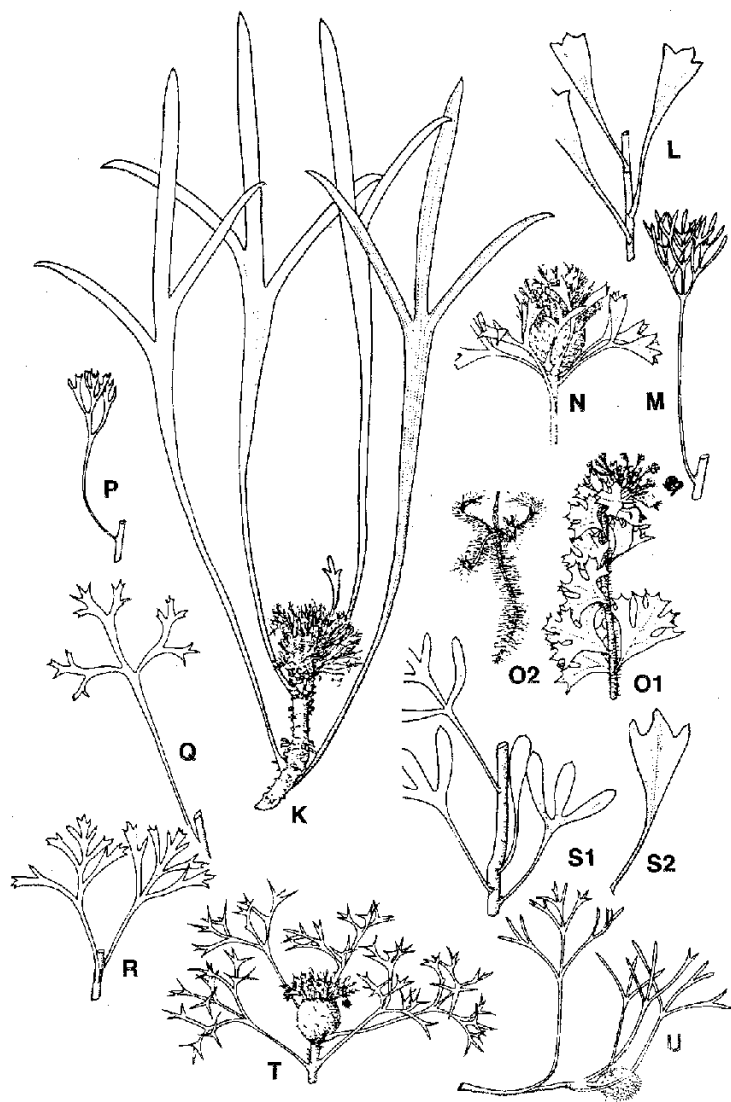


Figure 3 — *Isopogon* with flat or slightly concave leaves but variously deeply lobed.

- K. *Isopogon alicornis*, flowering branchlet.
- L. *Isopogon tridens*, the leaves.
- M. *Isopogon dawsonii*, the leaves.
- N. *Isopogon dubius*, a flowering branchlet.
- O. *Isopogon baxteri*, a flowering branchlet and a flower.
- P. *Isopogon mnoraifolius*, a leaf.
- Q. *Isopogon petiolaris*, a leaf.
- R. *Isopogon anemonifolius*, two leaves.
- S. *Isopogon trilobus*, two variations of the deeply lobed leaves.
- T. *Isopogon ceratophyllus*, a flowering branchlet.
- U. *Isopogon prostratus*, showing its prostrate habit.



△ *Isopogon teretifolius*

Photographs by D. Foreman

Isopogon adenanthoides ▽





Isopogon divergens, Plant and flowers



Isopogon fletcheri (figure 2G) is an erect bushy shrub to 1.5 m tall. The leaves are undivided and with a very short petiole, leaf-blade flattened, to 12 cm long, tips sharp. Cones are terminal, solitary, sessile, up to 25 mm diameter in flower, to 20 mm in fruit. Flowers are creamy yellow to creamy green, to 16 mm long, Sept. to Nov. Restricted to the Blue Mountains in wet places on sandstone.

Isopogon formosus (photograph on page 80) is a shrub to 2 m tall. The leaves are variously divided or occasionally simple, petiole where distinct to 2.5 cm long, leaf-blade terete, to 3.5 cm long, tips sharp or needle-like. Cones are terminal or in upper leaf axils, sessile, to 60 mm diameter in flower, to 20 mm diameter in fruit. Flowers are mauve, pink to red, to 25 mm long, except a tuft of hairs on the tip of each tepal. Bunbury to Albany and Mt Manypeaks of WA.

Isopogon gardneri is a very prickly dense shrub to 1.6 m tall. The leaves are divided and interlacing, petiole to 2.5 mm long, leaf-blades terete, to 4 cm long, tips needle-like. Cones are terminal, sessile, 35 mm long in flower (flowers not spreading), 12 mm diameter in fruit, surrounded by persistent bracts. Flowers are pale pink to yellow, to 30 mm long, villous, appearing from September to December. It is restricted to inland areas in south-west of Western Australia in shrubland or open mallee, on laterite or sand.

Isopogon heterophyllus (figure 1E, photograph on page 69) is a shrub to 1.2 m tall. The leaves are simple or divided into 2 or 3 segments that are maybe further divided, with a petiole where it is distinct, to 4 cm long, leaf-blades rather thick, terete and with distinct longitudinal wrinkles when dry, to 4 cm long, tips needle-like. Cones are terminal, sessile, to 60 mm in diameter in flower, to 20 mm in fruit. Flowers are pink, lilac and pinkish mauve, 30 mm long, glabrous except for a tuft of hairs at the tip of each tepal, appearing from August to November. It is common and widespread along the south coast of south-west Western Australia in open woodland or shrubland on laterite or sand.

Isopogon inconspicuus is a low growing shrub to 80 cm tall. The leaves are pinnate and crowded onto branchlets, petiole 2 mm long, leaf-blade terete, more or less hairy, to 12 mm long, tip sharp. Cones are axillary, sessile, crowded towards the end of branchlets, to 30 mm diameter in flower, fruit to 5 mm diameter. Flowers are pink to purple, slender and tending to droop, to 25 mm long, covered with grey hairs, appearing from July to October. It is restricted to the sandplains and heathlands north of Perth and common around Mt Lesueur.

Isopogon latifolius (figure 2C, photograph on page 49 and 68) is a bushy shrub to 3 m tall. The leaves are undivided, with no distinct petiole, leaf-blade flat, thickened, broadest at the middle, to 14 cm long, tip sharp. Cones are terminal, conspicuous, to 80 mm diameter in flower, 45 mm diameter in fruit. Flowers are pale pink to purplish pink, to 35 mm long, glabrous except for a tuft of hairs at the tip of each tepal, appearing from September to December. In scrubland or mallee woodland on laterite or sandy soils, only in the Stirling Range.

Isopogon linearis (figure 2D) is a shrub to 1.5 m tall. The leaves are simple to 9 cm long with no distinct petiole, leaf-blade long and thin, flattened with thickened margins, tips sharp. Cones are terminal sessile, sometimes 2–3 clustered together, to 40 mm diameter in flower, 25 mm diameter in fruit. Flowers are pink, to 22 mm long, glabrous, appearing between August and September. It is restricted to a small area north of Perth and south of Geraldton and extending to Wongan Hills, in heath or shrubland on sand or laterite.

Isopogon longifolius (figure 2C) is a shrub to 2.5 m tall. The leaves are simple or deeply 2 to 3 lobed, petiole ill-defined to 3 cm long, leaf-blade flattened, to 15.5 cm long with tips blunt or sharp. The cones are terminal, sessile, to 25 mm diameter in flower, 26 mm in fruit. The flowers are yellow, to 15 mm long, silky villous, appearing from November to January. In heath or shrubland on sandy soils in the south-west of WA around the Stirling Range and Albany,

Isopogon mnoraifolius (figure 3P) is low growing shrub up to 80 cm tall. The leaves are simple or divided into several upwardly curving lobes which may divide again, petiole 7 cm long, leaf-blade flat, about 10 cm long, tips sharp. Cones are terminal, sessile, to 40 mm diameter in flower, to 22 mm diameter in fruit. Flowers are creamy yellow, to 20 mm long, glabrous at base villous at the apex, appearing in September. It is restricted to the north coast of New South Wales in open heath on sand or clay soils.

Isopogon petolaris (figure 3Q) is a low spreading shrub less than 1 m tall. The leaves are divided and held erect on petioles to 12 cm long, leaf-blade flat, to 7.5 cm long, tips needle-like. Cones are terminal, sessile and up to 20 mm diameter in flower and fruit. Flowers are yellow, to 10 mm long, glabrous except for a tuft of hairs at the top of each tepal, appearing from July to November. It is wide spread on sandy soils in south-eastern Queensland and north-eastern NSW.

Isopogon polycephalus (figure 2F) is a spreading shrub to 1 m tall. The leaves are undivided, with no distinct petiole, leaf-blade rather narrow, flattened, thick, to 21 cm long, tip rounded and ending in a sharp point. Cones are terminal or axillary, sessile, often clustered together, to 30 mm diameter in flower, to 20 mm diameter in fruit. Flowers are whitish to yellow or cream, to 15 mm long, glabrous, August and January. Confined to coastal or near coastal areas in heathland or sandplains in sandy soil, between Albany and Esperance, WA.

Isopogon prostratus (figure 3U) is a prostrate, spreading shrub 1 m or more in diameter. The leaves are variously divided into linear lobes, petiole 6 cm long, leaf-blade flattened, 4.5 cm long, with sharp tips. Cones are terminal, sessile to 35 mm diameter in flower, 20 mm diameter in fruit. Flowers yellow, to 12 mm long, glabrous except for a tuft of hairs on the tip of each tepal, appearing from October to December. It occurs down the east coast and nearby ranges from near Sydney to Gippsland, Victoria, in heath or dry sclerophyll forest on sandy soils.

Isopogon scabriusculus (figure 1D, photograph on page 76) is a widespread and variable shrub to 2 m tall. The leaves are simple or forked with no distinct petiole, leaf-blade sand-papery to touch, flat (or terete for ssp *stenophyllus*) to about 18 cm long overall, tips sharp or needle-like. Cones are terminal or rarely axillary, sessile to 35 mm diameter in flower, 16 mm diameter in fruit. Flowers are pink to red, to 18 mm long, perianth tube glabrous (or pubescent for ssp *pubifloris*), appearing from July to November. Scattered throughout the south-west of Western Australia, in the drier inland areas, in a variety of heath, shrubland or mallee habits, they grow on sand or laterite.

Isopogon sphaerocephalus (figure 2J) is a shrub to 1.5 m tall. The leaves are undivided with no distinct petiole, leaf-blade narrow, flattened, to 16 cm long, tip sharp. Cones are terminal, sessile, occasionally 1 or 2 extra cones clustered towards the ends of the branchlets, to 40 mm diameter in flower, 30 mm diameter in fruit. Flowers are white, creamy, yellow to pale yellow, to 15 mm long, the tips of the tepals completely hairy, appearing from July to January. Found in jarrah forest or woodland on laterite or sand, from Jurien Bay to Pemberton in WA.



△ *Isopogon trilobus*

Photograph by D. B. Foreman

Isopogon scabriusculus ▽





Isopogon uncinatus (above) Photograph by A. George

Isopogon teretifolius (figure 1E, photograph on page 72) is a shrub up to 2 m tall. The leaves are simple (ssp. *petrophiloides*) or much divided (ssp. *teretifolius*) with no clearly defined petiole, undivided part to 5.5 cm long, leaf-blade terete, to 12.5 cm long, tip sharp or needle-like. Cones are terminal, sessile, erect or dropping, to 40 mm diameter in flower to 25 mm diameter in fruit. Flowers are creamy pink to pale pink or dirty white tinged with pink, 15 mm long, densely hairy, appearing during September to October. Scattered throughout south-west Western Australia in shrubland and heath, on clay, laterite or sand.

Isopogon tridens (figure 3L) is a shrub up to 1.2 m tall. The leaves are without a clearly defined petiole, leaf-blade flat, narrowly wedge-shaped, 6.5 cm long, 3 toothed with each tooth ending in a needle-like point. Cones are terminal, sessile to 30 mm diameter in flower, 20 mm diameter in fruit. Flowers are white, 28 mm long, glabrous except for a tuft of hairs at the tip of each tepal, appearing during June and July. Restricted to a small area north of Perth around Arrowsmith to Eneabba, growing in heath or shrubland on sand.

Isopogon trilobus (figure 3S, photograph on page 68) is a shrub to 2 metres tall. The leaves are variously toothed or lobed, petiole to 5.5 cm long, leaf-blade narrowly wedge-shaped, flattened, rather thick, to 5.5 cm long, lobes terminating in a sharp or callose-like point. Cones are terminal, sessile to 30 mm diameter in flower, fruit barreled shaped, to 28 mm diameter. Flowers are cream to yellow, to 10 mm long, silky-pubescent, appearing between September and December. It is widespread near the coast in heath or shrubland on sand of south west WA.

Isopogon uncinatus (figure 2I, photograph on page 77) is a low spreading shrub to 40 cm tall. The leaves are undivided, held erect on a petiole to 15 cm long, leaf-blade flat, tapering towards the base, to 15 cm long, tips hooked. Cones are terminal, sessile, clustered at the base of the plant and concealed by the leaves, to 30 mm diameter in flower, 12 mm in fruit. Flowers are yellowish, 25 mm long, covered with silky hairs towards the ends of the tepals, appearing in October. It occurs in stunted jarrah forest on clay, in one locality north of Albany in Western Australia. Sometimes confused with *I. attenuatus*.

Isopogon villosus (figure 1A) is a tufted shrub to 60 cm tall. The leaves are divided, petiole to 13 cm long, leaf-blade terete, to 12 cm long, often grey-green, tips needle-like. Cones are terminal, sessile, often clustered towards the base of the plants, 30 mm diameter in flower, to 25 mm diameter in fruit. Flowers are cream to yellow, to 20 mm long, densely villous, from September to November, occurring in heath or shrubland on sand or laterite in the south-west of WA. ■

Hairy root clusters — continued from page 61

Conclusions

As nutrient-impoverished soils are characteristic of much of temperate Australia, species with these structures often dominate the landscape. Root clusters enhance the release and uptake of nutrients and they form preferentially in that part of the profile which is the main source of nutrients in leached soils: the decomposing litter. The highly sclerophyllous vegetation and prolonged summer drought ensure substantial litter build-up between fires. Certainly, the dense cover of long root hairs ensures good contact with the soil and litter particles, enabling immediate uptake of nutrients as they are released.

The uppermost (A_0) horizon is very prone to sudden and prolonged drying out, an environment more suited to root hair formation than to mycorrhizal fungal growth. The strength of the root hairs and the abundant mucilage may even provide a better link with the nutrient source under fluctuating moisture conditions than fungi. In addition, any competitive effect between the plant and its symbionts is avoided. In this respect it is worth noting that species with root clusters are rarely mycorrhizal (though legumes are still nodulated) which implies they both have a similar function. ■

Living with Australian soils

From the above the editor wishes to emphasise:

Species with these structures often dominate the landscape.

Root clusters form in that part of the profile which is the main source of nutrients.

Dense cover of long root hairs ensures good contact with soil and litter particles.

The uppermost soil layer is very prone to sudden and prolonged drying out.

An environment more suited to root hair formation than to mycorrhizal fungi.

The strength of the root hairs and the abundant mucilage may provide a better link with the nutrient source under fluctuating moisture conditions than fungi.

Any competitive effect between the plant and its symbionts is avoided.

Please turn to page 88, "**Australian soils are blowing away as dust**".

Wildflowers as Garden Plants

Newly described cultivars by W. H. Payne, Australian Cultivar Registration Authority*

Anigozanthos flavidus 'Flashpoint' has unusual variegated foliage. The orange flower spikes reach 1.8 m with the vigour of the species.

Austromyrtus 'Aurora' Is a shrub to 2.5 m used as hedging or feature plant. Seasonal colour changes of foliage range from red to deep burgundy being strongest from autumn to spring.

Brachyscome 'Sunblush' has large pink flowers occurring year-round on long stems above the deep green lobed foliage to 15 cm high. Ideal for garden edge or as basket specimen on sunny balconies.

Ceratopetalum gummiferum 'Silent Night' has a premium white flower with distinctive lime green foliage. It is a vigorous upright plant to 2.5 m tall by 1.5 m across with a heavy yield of flower calyx.

Grevillea 'Allyn Charm' is a seedling selection from *Grevillea* 'Sid Reynolds' with dark red flowers over a long period. The narrow dark green foliage forms a fast growing rounded shrub to 2 m high with a distinctly weeping habit.

Grevillea 'Allyn Glory' a seedling selection from *Grevillea* 'Sid Reynolds'. The bright red flowers contrast with the striking silver grey foliage. An upright, rounded bush growing 1–1.5 m high making a good feature plant or a hedge.

Grevillea 'Allyn Radiance' from prostrate forms of *G. juniperina*, red and orange. The clusters of bright red flowers, en masse, contrast well with dark green foliage. The prostrate, very dense foliage is not as prickly as other forms.

Grevillea 'Burgundy Beauty' is a fast growing shrub to 2 m high and 2–3 m across, the light green ferny foliage being smothered with burgundy flowers along the length of the branches. Extremely strong in winds and frost hardy, it is ideal as a screening plant attracting birds or as a specimen plant.

Grevillea 'Dot Brown' has rich dark gold and red flower heads to 15 cm long throughout the year with peaks in summer and winter. It is a hardy plant of medium size 1.5 m to 2 m tall, slightly spreading.

Grevillea 'Windara Eve' is a medium shrub to 1.5 m tall by 1 m across. The small red flowers are attractive in the variegated foliage.

Leptospermum 'Rhiannon' is a medium sized shrub of upright habit to 1.5 m tall with dark green glossy leaves and masses of large mauve pink flowers with fringed green centres in late spring.

Melaleuca 'Little Gem' is a very small slow-growing compact shrub 30–50 cm high with small, dark green leaves. The small rusty red flowers make this an interesting plant for small gardens and rockeries.

Ozothamnus diosmifolius 'Redlands Sandra' is spring flowering on attractive flowering stems to 70 cm long with heads of white flowers for cut-flower culture.

*The Australian Cultivar Registration Authority will register cultivar names, (names which are then protected), for plants of horticultural or commercial value. This does not prevent propagation and sale without payment of a royalty as does Plant Breeders Rights, but is very much cheaper. It serves to guide the consumer to the more reliable or better forms for gardens.



Isopogon formosus, plant and flower

Photography by D. Foreman



Pandorea jasminoides 'Southern Belle'. Although known as a climber it will make an excellent tub or basket specimen because of its compact and bushy habit and long flowering season, September to April in continuous heavy terminal clusters of large, rich pink, trumpet-like flowers that last for weeks even indoors.

Pandorea pandorana 'Lemon Bells' is a free flowering form with huge clusters of lemon bells along the stems, covering the plant during winter and spring. Foliage is a bright green and shiny, fast growing forming a dense thick cover of fences, pergolas or latticework.

Pilidiostigma glabrum — Dwarf Plum Myrtle, is a symmetrical upright shrub 1–2 m high and wide with dense foliage and red new growth in full sun to heavy shade.

Pimelia linifolia 'Snowfall' is a compact, vigorous hardy plant with long lasting large white flowers that cover the bush with some flowers throughout the year.

Scaevola aemula 'Summertime Blues' has been developed in Germany. The large mauve fan-shaped flowers are produced *en masse* in summer.

Westringia 'Elizabeth Bough' is a compact, rounded shrub to 80 cm high with soft green foliage and mauve-blue flowers in flushes through the year.

Westringia glabra × *fruticosa* 'Glabra Cadabra' has been called the Screen Machine. The dark, glossy, neat, dense foliage is quick growing to 1.5 m high remaining bushy to the ground. The masses of violet flowers are displayed in winter and spring.

Westringia 'Starry Night' has grey green foliage on a quick growing rounded and dense shrub to 1 m high. White flowers are displayed throughout the year. ■

New species, Wildflowers

Recently described

Notes compiled by W. H. Payne

Acacia thomsonii from the tropical dry zone of Australia, has seed that has **potential as a human food resource*** due to its high fecundity and its occurrence on harsh, stony sites. Other related species with similar potential are *A. coloi*, *A. cooleana* and *A. tumida*. *Acacia thomsonii* is a shrub/small tree 2–6 m tall to 3 m across with leaves (phyllodes) 8–17 cm long, 1–2 cm wide producing yellow, sausage-like flower spikes 15–30 cm long.

Anthocercis sylvicola, a rare new species closely related to *A. genistoides* and *A. anisantha* sharing with them a densely spiny habit to 2–5 m tall and small leaves occurring initially singly or in twos and on older branches in small clusters, but deciduous, both these with larger white flowers whereas *A. sylvicola* has smaller green and purple flowers. *A. intricata* is also a spiny bush but with sparse spines and larger leaves.

Banksia has been the subject of a cladistic analysis and a number of new species described. This will be the subject of a report from the Banksia Study Group but till then the new species are:

Banksia aquilonia was previously known as a subspecies of *Banksia integrifolia*. The leaf arrangement is spirally arranged but crowded, readily recognised through all stages of growth. It has a unique row of short stiff brown hairs each side of the abaxial leaf surface, the follicles typically are slightly larger.

*A potential food source that grows in tropical areas on harsh stony sites! See page 91.

Banksia brevidentata was previously known as a variety of *Banksia gardneri*. It is more closely allied to *Banksia goodii*.

Banksia hiemalis was previously a variety of *Banksia gardneri*.

Banksia dolichostyla was previously a variety of *B. sphaerocarpa* but is larger in all parts, particularly in perianth and style lengths and differs in its infrutescens.

Banksia penicillata, was a variety of *Banksia conferta* (allied to *B. paludosa*).

Cyathodes are unique epacrids of Tasmania known best for the way the bushes are decorated by bright fruits after flowering. This review has reduced the number of species to three only, *Cyathodes platystoma* being a newly described species. Their leaves appear whorled. Species formerly known as *Cyathodes* have been grouped in a new genera, *Planocarpa* (see below) and a new genus yet to be published and containing *Cyathodes juniperina* and allies.

Cyathodes glauca is a compact shrub, or a tall shrub to 2 m high. The small narrow leaves (13–48 × 2–5 mm) are rigid, pointed and usually 20 mm long. The small white flowers are followed by characteristically purple fruits (rarely white) 6–10 mm diameter.

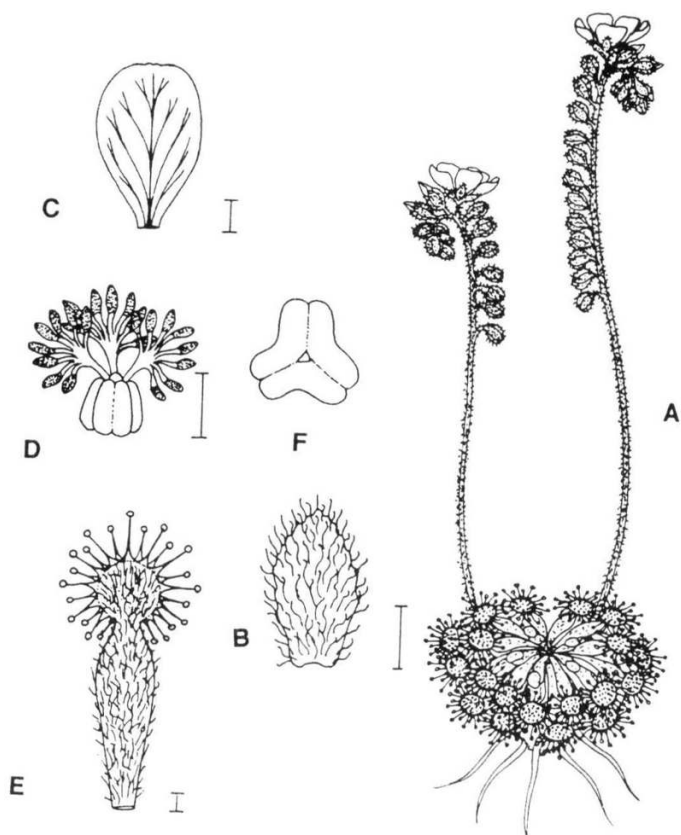
Cyathodes platystoma is similar but with broader leaves (36–62 × 5–7 mm). They may also be distinguished from *C. glauca* as the bell shaped flowers are not constricted at the throat but are more open or U-shaped.

Cyathodes staminea (syn. *Cyathodes macrantha*) is a spreading shrub with rounded (obovate to elliptic) but pointed leaves (7–15 × 3–5 mm) the small white flowers being followed by red fruit, more jelly-bean shaped.

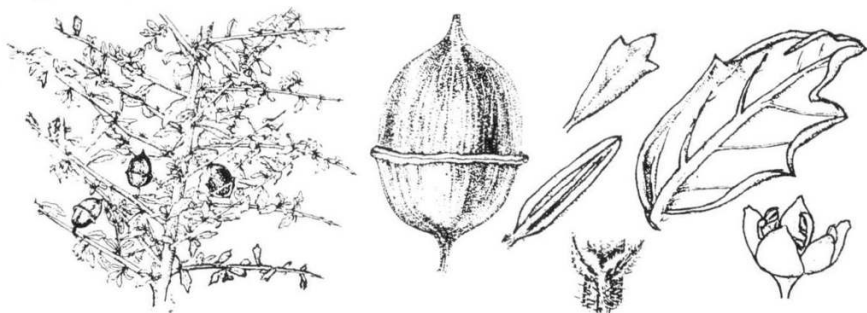
Drosera*. A large group of insect devouring plants. A group of *Drosera* known as *Lasiocephala* is presented with a key to the species in the group and descriptions of the new species, *Drosera brevicornis*. *D. broomensis*, *D. cadauca*, *D. kenneallyi*, *D. darwinensis* and *D. derbyensis*. The following key will provide a guide to this group of plants. The sketch of *Drosera darwinensis* shows the features including the unique "sticky" leaves that ingest the insects.

1. Leaf lamina obovate; inflorescence covered with short glandular hairs ***Drosera caledonica***
1. Leaf lamina orbicular to ovate; inflorescence glabrous or covered with non-glandular woolly hairs **2**
2. Only juvenile leaves with insect trapping lamina ***D. cadauca***
2. All leaves with insect trapping lamina **3**
3. Leaves at anthesis sparsely covered with appressed hairs, petiole visible **4**
3. Leaves at anthesis densely covered with appressed hairs, petiole hidden by dense hairy covering **4**
- Petiole oblanceolate, 2–4 mm wide ***D. ordensis***
- Petiole linear, less than 2–4 mm wide, covered with dendrite hairs ***D. lanata***
- Petiole wider, less than 2–4 mm wide, covered with non, dendrite hairs ***D. derbyensis***
4. Lamina reniform (kidney-shaped) 15–20 mm wide ***D. falconeri***
4. Lamina orbicular to ovate, 5–7 mm wide, leaves appressed to soil surface ***D. kenneallyi***
- Lamina orbicular to ovate, 2–4 mm wide, leaves horizontal to soil surface
- Lamina orbicular to ovate, 2–4 mm wide, leaves horizontal to soil surface, inflorescence 5–15 cm ***D. darwinensis***
- Lamina orbicular to ovate, 2–4 mm wide, leaves horizontal to soil surface, inflorescence 30–40 cm ***D. brevicornis***
- Lamina orbicular to ovate, 2–4 mm wide, leaves erect to semierect **5**
5. Petiole oblanceolate, inflorescence to 18 cm long, pedicels 3–7 mm ***D. dilatato-petiolaris***
- Petiole oblanceolate, inflorescence to 45 cm long, pedicels 2–5 mm ***D. fulva***
- Petiole linear, inflorescence glabrous ***D. broomensis***
- Petiole oblanceolate, inflorescence covered with woolly hairs ***D. petiolaris***

Sundews, *Drosera, unique carnivorous plants, spectacular but small. Grow them as described in our Volume 18, page 126. Try a Terrarium Garden.



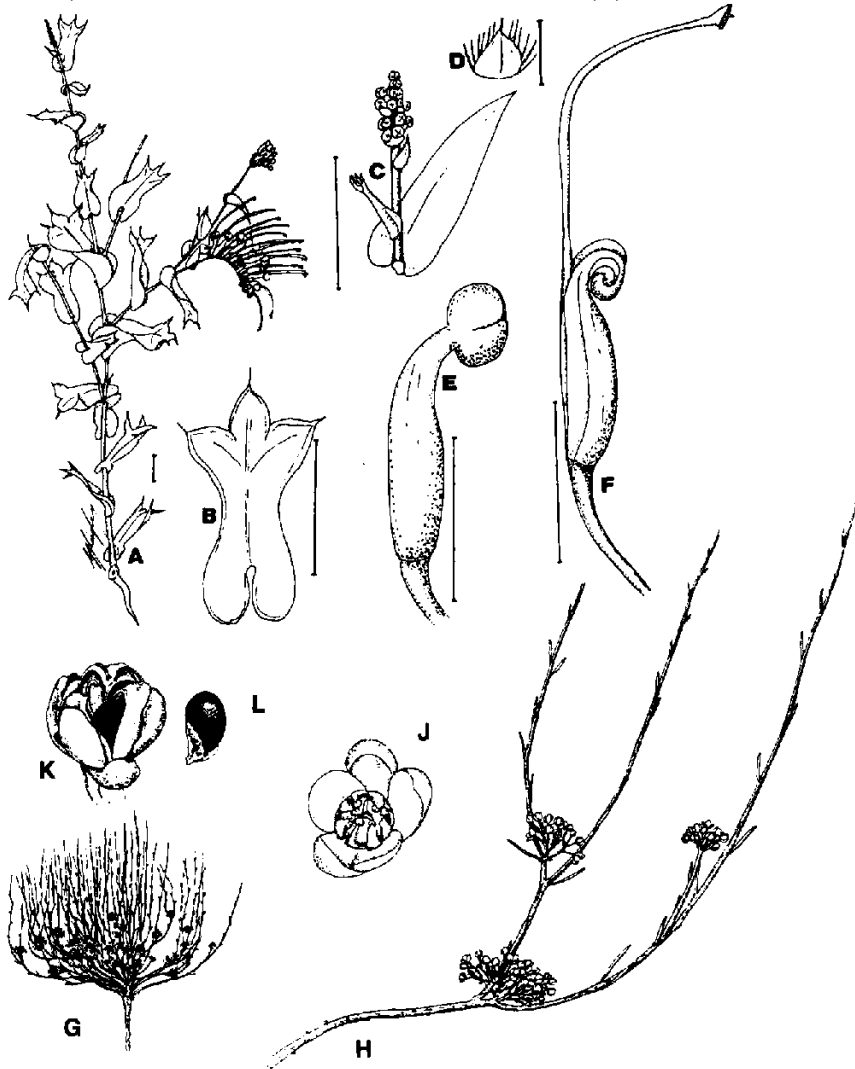
Drosera darwinensis, A: a plant showing the rosette of sticky insect devouring leaves (each leaf as in detail E) at the base of two flowering stems, the white flowers opening one at a time from the top, the flower comprising 5 sepals (detail B) cupping 5 petals each as in C, the center of the flower (gynoecium) as in D and the ovary as in F.



Granitites intangendus, The habit, leaf and fruit are shown in the sketch. The only species in this new genus. It belongs to the plant family Rhamnaceae and has been confused with *Pomaderris* and *Cryptandra*. It is allied to *Alphitonia* which also has large black fruits with a mealy layer. A semi-prostrate to erect shrub to 2 metres high with small white to pinkish flowers.

Grevillea maccutcheonii is a critically endangered new species differing from *Grevillea manglesioides* and the two other related taxa in the complex, *G. diversifolia* and *G. papillosa* in having panduri form, rigid, stem-clasping leaves (figure 6B) and larger flowers. All ages of vegetation and floral organs are glabrous with the exception of the margins of the floral bracts. It is also related to *G. ripicola* differing in leaf characteristics.

A, the plant; B, mature leaf; C, flower head; D, bract; E, flower in bud; F, mature flower.



Macarthuria in the family Molluginaceae, previously included in Aizoaceae, a family of succulents. They are perennial herbs, subherbs or shrubs. The six WA species, *M. apetala*, *M. australis*, *M. georgeana*, *M. intricata* and *M. keigherlii* are described. G, a bush; H, a flowering branch; J, flower; K, fruit; L, seed.

Heliotropium, a large genus with 81 species occurring in Australia is reviewed by L. A. Craven with 50 new species being described. The genus belongs in the plant family Boraginaceae, the Australian species being annual to perennial in their duration and herbs to shrubs in form.

Kunzea, 21 species from WA in three subsections are described including 16 new species. This group of plants will be presented in more detail shortly.

Lachnostachys, **Newcastelia** and **Physopsis** are reviewed and will be presented in a future issue. Three species are transferred from **Newcastelia** to **Physopsis** and a new species **Newcastelia roseoazurea** described.

Microtis graniticola does not occur outside semiarid areas where it is confined to granitic iselbergs. The nodding green flowers are in a dense spike to 6 cm long, 20–5 cm high. **Microtis media**. The four subspecies are defined.

Prasophyllum paulinae, a rare terrestrial orchid extending inland from the Shark Bay, Israelite Bay area, closely allied to *P. macrostachyum* which has more widely separated flowers to 9 mm long and *P. gracile* with lateral sepals which has longer terete apices to 2.5 mm long.

Planocarpa is a new genus of the three species below all formerly known as *Cyathodes*. The group shows some affinities to *Acrotiche* and *Monatoca* and are separated from *Cyathodes* by: the inflorescence is axillary with 1–3 flowers in a spike, not singly in the leaf axils; the smaller flowers have a shorter corolla tube with spreading lobes and short enclosed filaments; the fruit is a depressed sphere, red or red-black; the leaves are not alternate but in obscure seasonal clusters.

Planocarpa nitida (syn. *Cyathodes nitida*) is a compact shrub to 40 cm high, the white flowers with spreading hairless lobes about equal to the calyx in length. The red-black fruit is shiny.

Planocarpa petiolaris (syn. *Cyathodes petiolaris*) is a diffuse or compact shrub to one metre high. The small white flowers with densely hairy lobes being greater in length than the calyx. The red or red-black fruit is dull.

Planocarpa sulcata (syn. *C. sulcata*) is similar to *P. petiolaris*, usually a lower compact shrub to 40 cm high but with the lower leaf surface 5 veined (not 7–9) and the upper surface with a centred groove and recurved margins; fruit is shiny.

Rhamnaceae of Western Australia are defined for genera *Pomaderris*, *Siegfriedia*, *Spyridium* and *Trymallum*.

Scaevola kallophylla is newly described as a distinct species from *Scaevola oldfieldii*. It is a pubescent, leafier shrub to 0.8 m found on the sandy coastal plain between the Murchison and Greenough Rivers, whereas *S. oldfieldii* is a glabrous-leaved shrub to 2–3 m from rocky slopes. *Scaevola kallophylla* has sessile flowers (16–36 × 20–35 mm) white streaked with maroon along the veins.

Stylidium fimbriatum also from the Kimberley, has characteristic yellow appendages (like spikes) in the throat of the pink flowers held above a rosette of leaves each to 10 mm long. In this way it differs from the similar *S. dunlopianum* and other tropical trigger plants.

Tetragonia coronata may now be added to the seven species described in *Australian Plants*, Volume 14, page 56. Previously included under *T. tetragonoides* it is an annual herb with the longest fruits and five petalled yellow flowers, other species usually having only 4 petals.

Wurmbea saccata is found south east of Onslow. It is unique in the genus having nectar pouches at the base of the pale pink flower petals (sepals). It resembles *W. densiflora* with dense inflorescences of pink flowers.

Index for *Australian Plants*

A comprehensive index for all issues of *Australian Plants* from Volume 1 to Volume 18 will be available in 1997. There will be a limited number of copies. To secure a copy it will be necessary to first place an order with the Secretary of the Society in your state. Non-members may place their order with the Editor, *Australian Plants*. Do not send any money at this stage as it will be some months before they are available. It is proposed to print only enough copies to fulfil these firm orders. Without a doubt the index will become a rare and valued item in the future. The index will be included in the limited number of fully bound Volume 18 so this may be an alternative method of purchase. The fully bound index with firm cover will be \$10, and the bound volume 18 will be \$45. Features of the index will be:

Index A, an index using only the more generally used common names of wildflowers for ready reference by beginners, and various subjects of interest such as plants for, Alkaline conditions, Alpine plants, Annuals, Art/Craft, *Banksia*, Bark, etc;

Index B, Plants for specific applications such as Alpine plants, Attractive foliage, Aromatic plants, Annuals, etc;

Index C, Plants for specific areas of Australia such as tropical areas, dry inland areas, cold climates, etc.;

Index D, Creating and maintaining the wildflower garden, the practices that have proven successful for other wildflower growers;

Index E, Propagation of plants from seed, cuttings, by grafting, etc. References for specific plants are in Index F using the symbol X with the page reference.

Index F, the major section of the index where the many thousands of species are indexed in generic order with the plant family given.

The **correct pronunciation** for the generic of first part of the scientific name of a plant. It is hoped to stimulate its wider adoption as a common name to groups of wildflowers.

The **best reference** to each plant is in bold type. There are often many references to a particular plant and the difficulty of using a previous index has been overcome by directing you to the best references first.

All **references** give a page number followed by a letter indicating:

C, the reference deals with **cultivation**

D, a plant **description** or an indication of its origin in nature.

L, a **line drawing** is provided to aid identification.

P, a colour **photograph** is provided.

X, the reference includes remarks on **propagation**.

Australian Plants is a valued reference with considerable data not available elsewhere. It is a link between the scientific community where it is often referred to, and the general gardening public for whom the information is presented in as simple a form as possible. The reference to correct pronunciation of scientific names will be of particular value setting for the first time, a standard to use.

This index is long overdue. It was an enormous amount of work and covers hundreds of pages. I regret that it is not cheaper to purchase a copy. Those of you who have saved their *Australian Plants* over the years in the specially prepared binders will appreciate just how hard it has become to access the wealth of information that has been provided, information that is not available anywhere else. The index is also available on disc in Word 6 format. A copy of this disc will also be available for \$10 but only from the Editor.

Living with Australian Soils

W. H. Payne*

Our soil is blowing away as dust! Salination is creating wasteland!

"Australia is an old continent and its soils are usually nutritionally poor and highly leached. Our native vegetation has adapted to these conditions by forming mutually beneficial associations with micro-organisms which improve the supply of mineral nutrients. Mycorrhizal fungi also play a direct part in stabilising the soil . . . binding the soil particles together. Soil is eroded away when the fungal filaments are no longer dense enough to prevent wind and water removing the soil particles".** "Hairy Root Clusters — Why are they so abundant in the most nutrient-impovertised soils in Australia", see the article presented on page 60. It is the restoration of our native vegetation in marginal areas that is so critical.

Our soil is blowing away to dust!

Action is needed to stop our soil from blowing away and still produce efficiently from our land to feed and clothe people and maintain prosperity by:

1. The production of mycorrhizal fungi in pellet form as is done with some commercial crops. This will assist in rehabilitation of eroded sites.
2. The rehabilitation of natural areas providing ground cover and possibly products for food and the maintenance of prosperity.
3. Good farm management practices. In our last issue it was shown that the rural community is desperate for guidance leadership in this area.
4. Develop a national strategy for land use. Over the last 10 years 5 million hectares of land have been cleared or 50,000 hectares of land cleared per year. 3 million hectares of land will be cleared over the next 5 years. This devastation makes the current effort by concerned people look puny.
5. Suppression of feral pests, rabbits, goats, foxes, pigs, horses, etc. that are eating out our native vegetation, the single largest factor in desertification.
6. Suppression of the underground fungi that is deviating our vegetation faster than we are planting it. A national research plan is needed.
7. Eliminate the progressive loss of land to salinated waste. In the Murray-Darling basin alone dryland salting effects about 200,000 hectares with a further one million hectares at risk. In Western Australia dryland salinity will effect 2.9 million hectares of land in 2010. See item 9 below.
8. Plant trees. Since the One Billion Tree (OBT) scheme was launched in 1989 700 million trees have been planted. The CSIRO estimates that 12 billion trees need to be planted in the Murray-Darling basin alone to ensure soil and water salinity stayed at moderate levels or was reduced.
9. Australia is in a quick-sand of salt. Planting trees saves our land going to waste-land and maintains food production but for how long? The salt keeps building up and will slowly engulf us no matter how many trees we plant. We need to develop a strategy to remove the salt and luxuriate in clean fresh water. A following article is a step in the right direction.

*For five years we have been campaigning for the adoption of a survival management plan as a major objective for the 100 years of federal government celebrations in year 2001. The above forms part of these recommendations. Hopefully readers will be patient with me in presenting part of this plan once again as, with the formation of the responsible authority at last, this may be the final opportunity we get to submit our plan.

**Quoted from "Living with Australian Soils" by Dr P. E. McGee, *Australian Plants*, 17: 40.

Our Management Plan For Australia's Future

Living with Australian soils is a very brief summary (possibly the scientific reasons presented in as simple a way as possible) of what we hope will be seriously considered together with the rest of our proposal. Our major objective is to involve all Australians in this national campaign for future survival and prosperity. There are many pilot projects in hand showing that all our proposals are practical and that there is already a core of trained and enthusiastic workers. An illustration of what can be done is as follows:

Children and the environment

Sustainability is about investing in the future of our country and its people.

"Special Forever" encourages primary children to think about and record what is important to them about the environment. It allows children to tell the rest of the community what they value and what they believe the future should hold.

Almost 38,000 primary students from throughout the basin took part in the third year of the "Special Forever" writing project in 1995. This scheme was initiated by the Murray-Darling Basin Commission* as part of its support for community education as school children are the future custodians of the Murray-Darling Basin. Topics of the study include: "My special place", "Special people", "Special flora and fauna", "Special events", "Special environments" and "Keeping my place special".

Feedback suggests the project generates considerable discussion in families and communities about the basin and the issues of concern. It promotes greater awareness of the geography, land use, and cultural heritage and flora and fauna of the region.

The important role that school children can play in environmental management and their ready access to the wider community is demonstrated. Their efforts are encouraged when what they have to say is respected and valued and shared with their communities. Each year about 250 students have their work published in a book, a positive indication that what they have to say is valued.

*The Murray-Darling Basin Commission (GPO Box 409, Canberra City 2601) is charged with the conservation of the vast areas forming the Murray and Darling River systems. It is initiating effective schemes for the long term restoration of this vital area. It is to be especially commended for its promotion of public awareness of the disaster threatening the area and the need to involve all its dependent communities. This scheme was promoted in: Australian Farm Journal, Sustainable Agriculture, published by Rural Press, Box 160, Port Melbourne, 3207.

Dryland Salting, A New Theory

The Red Barren Project

Rising water tables in certain parts of Australia which lead to the loss of pastureland and vegetation to rising salt, are usually believed to be caused by deforestation of re-charge areas on the upper slopes. The problem has been addressed by the farming community in parts of Australia by the planting of trees on an enormous scale. In Western Australia the tree planting has been preceded by the building of cut-off drains built at great cost.

Continued on page 90.



Honey Possum *Tarsipes rostratus* feeding on *Banksia grandis* (Proteaceae), Millbrook Nature Reserve north of Albany, Honey possums are the only non-flying mammals known to feed only on pollen and nectar. Photo: S. D. Hopper.

Gondwanan Heritage

Past, Present and Future of Western Australian Flora and Fauna

Western Australia has drifted twice, to the North Pole, to the South Pole and is now moving north again. The introductory chapter reviews this progress through time as an epic voyage for the reader. The oldest rocks and fossils in the world. The oldest exposed landscapes in the world. It has been covered in rainforest. At the present point in time there is an extraordinary rich array of animals and plants and this book is a record of a symposium in Perth in 1993 to examine their place in the environment, their evolution and their interaction (photo above). It was a gathering of scientists and the book reproduces the papers presented so that it is not a book for everyone. However, it is a significant contribution to man's study of evolution and evolving science and a very valuable record. It is one of a large number of similar symposium records produced in book form by Surrey Beatty & Sons and is available from them at 43-45 Rickard Road, Chipping Norton, NSW 2170 for \$80.00.

In the Dundas Tablelands of western Victoria, near Balmoral, the Balmoral Land Care Group have worked as hard as any other group in Australia to fence off gullies and plant trees, but they found the problem was not going away. The bare ground was only creeping further up the slopes and the gullies were oozing reddish gels and oily substances.

About six years ago agricultural consultant Bill Gardner and local landholder Chris Hindhaugh began searching for the answers to such problems. Dr Gardner believed it was a case of the water being trapped under pressure and that they should find some method to let it run away. An excavator was brought in to dig a trench 200 m long and up to 6 m deep in a sealed discharge area on the Hindhaugh property "Englefield". The result was that the drain now runs fresh water, the water table has been lowered over 2 m through the whole gully, the pasture is recovering and the bare red ground has largely disappeared.

In 1996 the experiment known as "The Red Barren Project" is being extended with the aid of \$60,000 provided from the Elizabeth Murdoch Trust. The idea is to use underground explosives to fracture subsoil layers and so allow trapped water to escape. This is followed with the planting of native swamp species to prevent the soil clogging up again. The first explosions were set off recently on "Englefield", as well as on Don and Jenny Smith's nearby property. They were set off 6 m below ground level and are believed to have fractured the subsoil in a 6 m diameter. Improvement was immediately apparent.

This work follows that of Dr Rob Fitzpatrick from the CSIRO Division of Soils who has been trialing the same process in the Adelaide hills, where similar problems need solving. Dr Gardner believes that dryland salinity management in Australia is way off target. His theory is that the problems are due to iron oxidation in ground water; occurring in acid soils, which cover 90% of Australia.

Prosperity From Australia's Natural Resources — 1*

Based upon material supplied by Australian Native Produce Industries*

The Australian Native Food Industry is small, but expanding. It has an annual turnover of around \$14 million. Grower groups are forming to specialise in native foods, small manufacturers are producing native food products for the gourmet market, and large food processors are now incorporating native ingredients into their mass produced products. Native food restaurants are thriving in all capital cities, and many mainstream restaurants are including native ingredients in their every day menus. To meet the demand and to reduce harvesting pressure on native plants and animals in the wild, there is a need to start farming in an ecologically sound way.

In 1995, the Commonwealth Government established the Australian Native Bushfoods Industry Committee (ANBIC) to help the emerging native food industry. ANBIC's goals are to increase the annual turnover to \$100 million.

*Based upon material supplied by Australian Native Produce Industries Pty Ltd (ANPI), an Australian-owned and operated company formed in 1992, in part to help supply the multiple award winning Red Ochre Grill restaurants in Adelaide, Cairns, Melbourne and Sydney. This series will be continued in future issues. The section on wattles is taken out of context from the information supplied as I wished to feature them. It shows the excellent presentation used for a large number of plants that are needed to meet market demand. The company welcomes enquiries from prospective growers.

The seeds and pods (ripe and green) of selected *Acacia* species are traditional foods of Australian Aborigines. There is growing interest in their use for human nutrition in the developing world. Brand and Cherikoff (1985) have demonstrated that ripe seeds of *Acacia* species are typically high in protein (17 to 25%), fat (4 to 16%), and carbohydrate (30 to 40%). A highly palatable and nutritious flour is made by roasting and milling (generally hammer milling) the seeds of some *Acacia* and *Brachychiton* species. The flour may be incorporated into damper, breads, cakes, pastries, desserts, and made into beverages. There is a small but growing market for the flour of these species.

Acacia retinodes (Wirilda) is an evergreen, upright, multi-stemmed shrub to single stemmed small tree (3 to 8 m). Fresh-green leaves (phyllodes) of variable length to 200 mm long. Pale yellow ball-shaped "wattle" flowers mostly in Winter or Spring. It occurs in low to moderate rainfall areas (400 to 1 000 m) of temperate SA, south-western Vic and Tas. on broad range of soil types.

Culinary Uses. Seeds generally ripen late Summer to Autumn. Good quality flour is produced by roasting and milling cleaned seed.

Cultivation Comments. Attractive, and adaptable species of very fast growth. Nitrogen fixing legume. Tolerant of moderate frost, drought, coastal exposure, lime and saline conditions. Suitable for heavy textured soils with some waterlogging. Generally lives 7 to 15 years, but can live much longer.

Estimated Yield and Gross Return. This crop lends itself to dryland cultivation. For estimating purposes, at a spacing of 4 × 6 m (416 trees per ha), allow a yield of 1.5 kg per tree in the fourth season after planting. At a farm gate value of \$10 per kg, a gross return of \$6,240 per ha could be achieved.

Acacia victoriae (Elegant Wattle) is an evergreen, spreading, multi-stemmed shrub to single stemmed small tree (2 to 5 m), sharp spines present at all stages of development. Blue/grey-green leaves (phyllodes) 20 to 50 mm long. Cream coloured flowers generally August to December. It is a very widespread species in nature, growing naturally in low rainfall areas (125 to 500 mm) of temperate to sub-tropical SA, NT, WA, Vic, NSW and Qld on a broad range of soil types.

Culinary Uses. Seed generally ripens November to January. High quality is produced by roasting and milling cleaned seed. This is currently the principal species used for wattle seed flour production.

Cultivation Comments. Very adaptable multi-purpose species for hot, low rainfall areas on a broad range of soil types. Moderate early growth becoming rapid once established. Nitrogen fixing legume. Moderately palatable forage species and is browsed (particularly by cattle) despite sharp spines. Tolerant of heavy frosts, severe drought, lime and saline soil conditions. Will also tolerate brief periods of waterlogging and heavy textured soils. Good "hazard plant" for landscaping and responds well to hedging or pruning. Lives 7 to 10 years.

Estimated Yield and Gross Return. This crop lends itself to dryland cultivation. For estimating purposes, at a spacing of 4 × 4 m (625 trees per ha), allow a yield of 1.5 kg per tree in the fourth season after pruning. At a farm gate value of \$10 per kg, a gross return of \$9,375 per ha could be achieved.

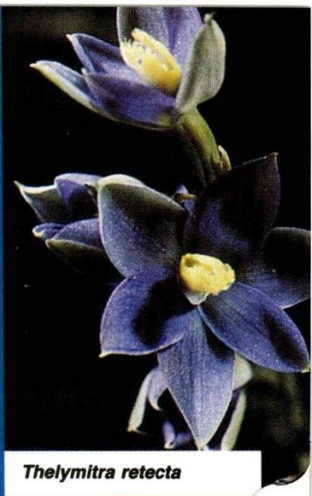
Editors note: I selected this section on wattles because of the comment on page 81. There is a huge potential for the commercial cropping of our native vegetation in many areas of Australia that will only support our own flora.



Thelymitra epipactoides



Thelymitra circumsepta



Thelymitra relecta



Thelymitra azurea



Thelymitra media



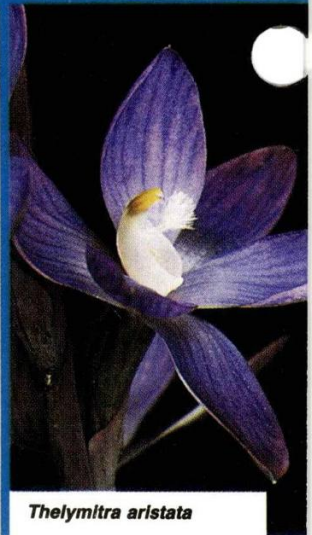
Thelymitra purpurata



Thelymitra lxioides



Thelymitra lxioides var.



Thelymitra aristata



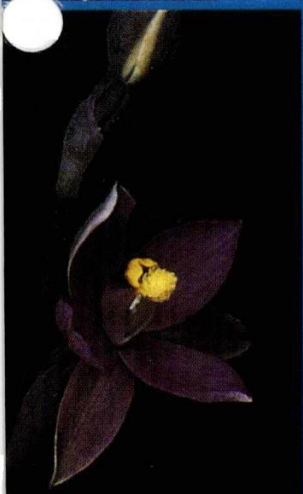
Thelymitra decora



Thelymitra merranlae



Thelymitra × *truncata*



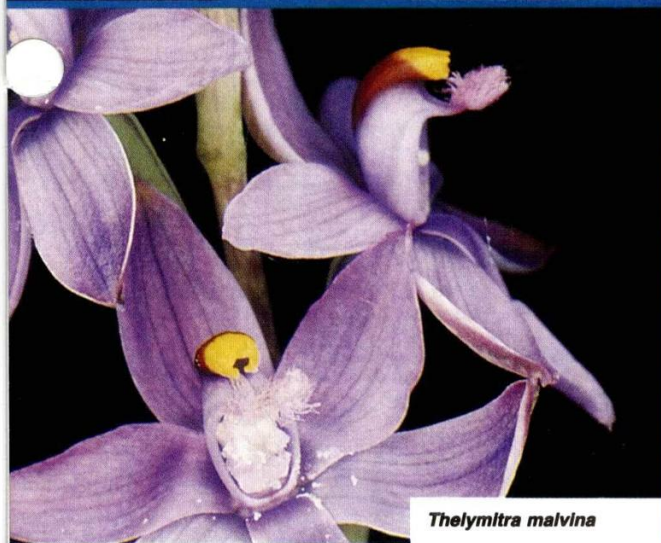
Thelymitra luteocillium



Thelymitra × *chasmogama*



Thelymitra mucida



Thelymitra malvina



Thelymitra holmesii

Discover Nature's Wonderland of Terrestrial Orchids

Coming across an orchid during a stroll in the bush is one of the special delights enjoyed. It is usually a small terrestrial of exquisite design if examined closely. Until now, however, identifying this treasure has been difficult even for the expert. A new book **Orchids of New South Wales and Victoria, A Field Guide** by Tony Bishop enables you to name the plant just by looking at the colour photographs, a sample of which is given on the previous two pages.

Thelymitra, **Sun Orchids**, grow from a tuber, that throws up a solitary long thin leaf, then a flower stalk usually with a number of buds on the end. The Spotted Sun Orchid, *Thelymitra ixioides*, is quite common and representative of the group. The single, ribbed leaf is to 20 cm long, the flower stem to 60 cm with up to 9 flowers about 30 cm across. The flowers are usually blue or pink and spotted. It may be identified also from similar species by the white tufted hairs on the central flower parts. This book, for the beginner, is selling at \$27.95.

Wildflower Nurseries in Queensland

Fairhill Plants and Botanic Gardens — Huge range; rainforest plants, grafted grevilleas, rare plants, wildflowers, ferns, orchids, revegetation trees. Extensive display gardens. Open every day 8.30 a.m.–5.00 p.m. Fairhill Native Plants, Fairhill Rd., Yandina, Qld 4561. Tel. (074) 46-7088.

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

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

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

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

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

Australian Wildflower Seed Suppliers

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

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

Australian Plants Is your periodical and needs your help! — Every reader can help but will you? We need reports on what plants you have grow and ideas of what you would like to grow. The last issues have been about Proteaceae, the Firewheel Tree, Native Honeysuckle, The Conesticks and Drumsticks. Soon we will have more on Banksia and Smokebush. We need notes on the tropical and rainforest species. Please send reports on their cultivation. **Hibiscus!** there will be an issue on these showy plants. Please send any notes you can. Colour slides are especially important. —Editor

Colour photography! I desperately need help, please do not ignore me if you can help at all. The best reproduction is from colour slides but fewer people are using this kind of film. The reproduction from good prints has now reached the stage where the quality is almost equally as good. Please let me see any good photographs that you have.

"Australian Plants", The Australian Flora Periodical

Past issues are available in volumes 4-10/11 (except 8), each volume is bound and cased, beautifully presented for \$21.00, plus \$5.00 post. Volumes 16 and 17 will not be available bound. Volumes 12, 13, 14 and 15 are available only from The Editor, Australian Plants, 860 Henry Lawson Drive, Picnic Point 2213, for \$40 each plus \$6 postage. Binders to hold the eight separate issues of Australian Plants in a volume are \$5.50, plus \$3 post.

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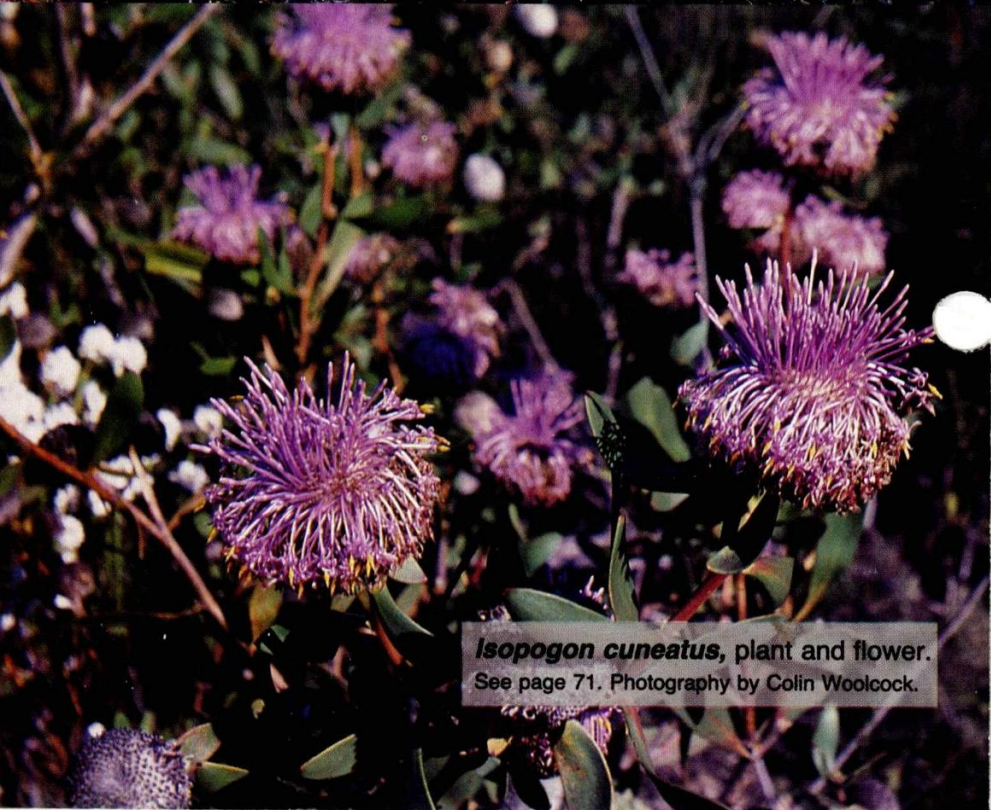
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***Isopogon cuneatus*, plant and flower.**
See page 71. Photography by Colin Woolcock.