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KANGAROO PAWS — Contents of This Issue

The plants known as "kangaroo paws" are unique in the world's flora. Typifying Australia in the same way as the kangaroo, the wattle trees and the eucalyptus trees, these fascinating plants are even "classical" for the strangeness of the unusual flora of south-western Australia, where they grow naturally.

They are superb horticultural plants. What is more appealing in a garden than the rich velvety red and green of the kangaroo paw known as *Anigozanthos manglesii*, standing up erect to almost one metre high. Less widely known but equally appealing is the living gold of *Anigozanthos pulcherrimus*, the rich deep red of *Anigozanthos rufus* or the unusual *Anigozanthos preissii*. Especially suited for use in rockeries is the "catpaw", *Anigozanthos humilis*.

Why then do we not see the "kangaroo paws" grown more widely? They are easy to propagate from seed and easy to grow. There are three main reasons: (a) the snails love them, you must keep them surrounded by snail bait — (b) the best ones, *Anigozanthos manglesii* especially, seem to give of their best for only one year, possibly two, and hence should be regarded as perennials. Unfortunately the nursery trade have not been astute enough to market them as such, selling a number of small seedlings in punnets, instead of individual plants and expecting their full pound of flesh as is more reasonable for a long lasting shrub — (c) they suffer from an ink disease.

What then is the solution?

The Wildflower Nursery Trade

Some of the specialist wildflower nurseries are doing a magnificent job in propagating only from the best forms of plants. Patronise those who are doing this. There is still a long way to go. Where can you buy punnets of seedlings especially of annuals or perennials?

The Wildflower Seed Trade

For plants such as *Anigozanthos* we need more careful seed selection.

Proper Care to Produce Good, Healthy, Vigorous Plants

The article by Jim Webb on page 220 is the result of careful observation and scientific study of growing conditions necessary for the vigorous healthy cultivation of our Australian plants. He has produced vigorous healthy plants that are disease and frost resistant. His work may mean a revolution in the successful cultivation of many of our wildflowers.

Hybridisation of *Anigozanthos* Species

One species of kangaroo paw *Anigozanthos flavidus*, has proved especially hardy, long lived, and easy to grow. One logical step is to hybridise this with more spectacular species as described from page 213.

The Selection of Good Forms

I feel that the major gain can be made by proper selection from good forms of true species. Good forms of *Anigozanthos flavidus* are now being marketed and there is still room for development. The variation in form of the other species is considerable and careful selection is overdue.—Editor.

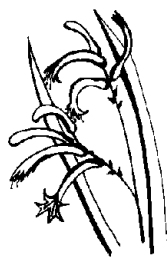
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COVER PLATE: *Anigozanthos manglesii*

— Photography by G. Chapman

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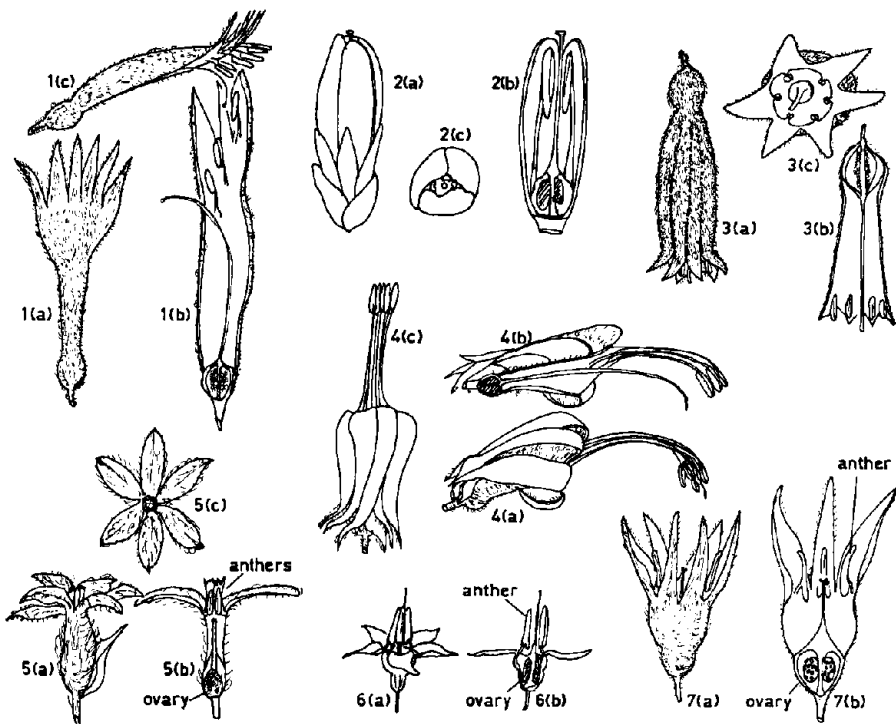
Growing Kangaroo Paws and Related Species

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Introduction

The kangaroo paws and their relatives belong in the Haemodoraceae, a family of approximately 13 genera and 90 species of perennial herbs occurring in Australia, Malaysia, South Africa and the Americas. The family is best developed in Australia, where seven genera and approximately 70 species are known, most being confined to the South West Botanical Province of Western Australia. The flowers for each genus are as follows:



THE PLANT FAMILY HAEMODORACEAE — Flower Details. Sketch by Greg Keighery.

Fig. 1. *Anigozanthos humilis* flower from top (a), side (c), and bisected (b) to show style on ovary with anthers.

Fig. 2. *Haemodorum breviseptum* flower from side (a), top (c), and bisected (b) to show anthers beside style.

Fig. 3. *Blancoa canescens* flower from side (a), top (c), and bisected to show anthers at end of floral tube.

Fig. 4. *Macropidia fuliginosa* flower from side (a), top (c), and bisected (b) to show style from ovary and anthers.

Fig. 5. *Tribomanthes australis* flower from side (a), top (c), and bisected (b) to show style and anthers.

Fig. 6. *Phlebocarya ciliata* flower from side (a), and bisected (b) to show style on ovary and anthers.

Fig. 7. *Conostylis aculeata* flower from side (a), and bisected (b) to show style on ovary and anthers.



Anigozanthos rufus (left) ***A. rufus* x *A. flavidus* hybrid** (right)

The plant on the right is an Fi hybrid of *A. rufus*, the plant on the left, and *A. flavidus*, a much hardier and more vigorous plant. Both plants are two years old and were grown in free-draining sandy soil with no artificial fertilizers. The hybrid has inherited foliage characteristics and the vigour of *A. flavidus*, resulting in a much larger plant than *A. rufus*. Flowers of the hybrid are similar in colour and shape to those of *A. rufus*. On page 211, the article "interspecific Hybrids of *Anigozanthos flavidus*", by Stephen Hopper describes his work in the development of horticultural hybrids of *Anigozanthos*.
Photography by S. D. Hopper

Two very distinct tribes are recognised among the Australian members of the family. Genera in the tribe Haemodoreae. (*Haemodorum*, *Phlebocarya*) are characterised by glabrous perianths with biseriate lobes divided to the ovary, whereas genera in the tribe Conostylideae (*Anigozanthos*, *Macropidia*, *Conostylis*, *Blancoa*, *Tribonanthes*) have tomentose perianths with uniseriate lobes that merge into a perianth tube above the ovary (except *Conostylis breviscapa*, where the lobes are divided to the ovary).

It is the members of the Conostylideae, and in particular the kangaroo paws (*Anigozanthos* and *Macropidia* spp.), that are best known among wild-flower enthusiasts and are most sought after as garden plants. The horticultural attributes of other genera in the family are poorly known.

In the present article we summarise our experience and that of the staff of King's Park in growing the kangaroo paws and their relatives. Suggestions are made regarding germination, propagation and other horticultural matters for each of the Australian genera of Haemodoraceae.

***Anigozanthos* (Kangaroo Paws, Catspaw)**

This genus is now known to contain 11 species, all restricted to the South West Botanical Province of Western Australia. The species have become world renowned for their spectacular colours and unusual floral

A Garden featuring ***Anigozanthos gabrielae*** (shown opposite)

This little known Kangaroo Paw is shown growing in the situation preferred by most *Anigozanthos* species. The flower detail is shown in the photograph on page 229. Of interest also are other plants in this garden. On the top right is a plant of the black kangaroo paw *Macropidia fuliginosa* featured in our colour plate on page 204. The small yellow shrub beside *A. gabrielae* is *Conostylis aculeata*. *Conostylis* will be featured in our next issue.

Photography by C. J. Wilson

structures, beautifully adapted for bird-pollination. The cultivation of each species in the genus is given on page 209 but let us first consider propagation and cultivation requirements generally common for all plants in the family.

Anigozanthos gabrielae —see description opposite



General notes on propagation

Seeds should be harvested in summer when fruits have dried out and commenced dehiscence. Seed germinates best if sown straight after harvest, but remains viable for several years. If no germination occurs in the first year, leave seed pots exposed to the elements in full sun during the summer and seedlings should appear the following autumn.

Seed sowing mixes need to be sandy. Only *Anigozanthos flavidus*, *A. bicolor* and *A. viridis* do well in heavier soils. Successful mixtures we have used include sphagnum moss peat: fine sand (1:1), or grey sand: cladium peat (8:1) or fine sand: coarse sand: loam: sheep manure and compost (12:6:1:4). Cover seed with a thin layer of fine blue metal gravel or coarse sand. If seeds are sown immediately after harvest (i.e. in summer), leave pots outside exposed to the sun and do not water until early-mid autumn. Once watering has commenced, check the seed pots every second day to make sure they don't dry out.

Germination should occur 15-40 days after the first watering. Heat pretreatment appears to boost germination in several species. Prior to sowing, place seeds in vials of water in a constant temperature waterbath at 55-60°C for one-two hours. The following table compares average germination rates for each species when preheated in this manner or sown directly without preheating.

	% Germination	
	Not Preheated	Preheated
<i>A. humilis</i>	2	7
<i>A. kalbarriensis</i>	0	0
<i>A. manglesii</i>	11	26
<i>A. viridis</i>	4	15
<i>A. bicolor</i>	0	19
<i>A. gabrielae</i>	0	12
<i>A. onycis</i>	0	20
<i>A. preissii</i>	19	40
<i>A. flavidus</i>	91	28
<i>A. pulcherrimus</i>	3	3
<i>A. rufus</i>	—	7

Seedlings are susceptible to damping off, which may be controlled by spraying with a suitable fungicide. Alternatively, sow seed thinly, ventilate pots freely, apply water at mid-day so that leaves dry off quickly, and prick out seedlings when young (as early as one day old). Seedlings (and adult plants) are also attacked by snails, rust disease and inkspot disease. Snails can be controlled using snail pellets, a suitable spray, or by removing snails by hand. Rust disease begins as small orange spots on the leaves that increase in size and eventually can kill the plant. It can be controlled by spraying with a thiram-based fungicide, or by methods used in the control of inkspot disease (see below).

Seedlings should be potted on or can be planted in the garden when they are 5-10 cm tall. Mulch the top of the pots and grow seedlings in full sun.

The best time to plant seedlings kept in large pots is the first autumn following sowing (i.e. when they are one year old). Ensure that freshly planted seedlings are well watered until the winter rains (for Western Australia) set in.

Several species, including *Anigozanthos bicolor*, *A. flavidus*, *A. gabrielae*, *A. preissii*, *A. pulcherrimus*, *A. rufus* and *A. viridis* can be propagated by dividing their rhizomes in March to May, when new shoots are 2-3 cm high. Split the rhizomes with a knife or spade, leaving two or three shoots per segment, and cut away all dead leaves, roots and rhizome segments. Pot segments and grow in a little shade until the plants recover in 2-3 weeks. Thereafter treat the new plants in the same manner as large seedlings.

General notes on cultivation

Fertilizers (preferably slow release types) may be applied in moderation to some of the hardier species (e.g. *Anigozanthos flavidus*, *A. viridis*, *A. bicolor*), but are not generally recommended. The longevity of all species except *A. flavidus* appears to be reduced by summer watering, since most have a summer dormant period in the wild.

To maintain adult plants, flowering stalks may be pruned down to the level of the leaves after flowering is finished. Old leaves should not be pruned until autumn, when new growth commences.

Several species are short-lived (1-3 years) in cultivation, including *Anigozanthos humilis*, *A. kalbarriensis*, *A. manglesii*, *A. onycis* and *A. gabrielae*. The other species usually live a few years longer. *A. flavidus* regularly attains an age of 10 or more years.

Ink Spot Disease

This disease is recognised by small black spots first occurring on the older leaves. These spots increase in size and join together, often causing the death of the entire leaf. In extreme cases the disease attacks the rhizome and secondary infection occurs, leading to the death of the plant.

Four different fungi have been isolated and are responsible for the disease, *Dreschleri iridid* being the most widespread, not *Mystroporium adustum* as is claimed in some literature. The origin of this latter name seems somewhat obscure.

The infection usually starts in late March or April, as the temperature decreases and humidity increases, producing ideal conditions for spore germination. Infection is usually through tissue damaged by snails, rabbits, beetle larvae, sand-laden wind, etc.

Spraying with fungicides appears to have very little effect on ink spot. This is not surprising, as each of the four diseases responsible may require a different fungicide to control them.

Some control of the disease is achieved by growing the plants in an open position in full sun, which will dry off the leaves quickly. Removing dead leaves from the plant and controlling surrounding weed growth helps keep the leaves dry. Also, watering by trickle irrigation or other means, so as not to wet the leaves, may be beneficial. Reducing summer watering to the absolute minimum and allowing the plant its natural dormant period often helps, since excessive use of water and fertilizer causes lush growth, which is more susceptible to attack. Controlling other pests that damage plants (e.g. snails) is also beneficial in retarding the spread of ink spot.

All kangaroo paws are susceptible to ink spot. Even *A. flavidus*, which is the most resistant species, will contract a little of the disease, but it never seems to be adversely affected by it. The most susceptible species are *A. humilis* and *A. kalbarriensis*, followed by *A. gabrielae* and *A. manglesii*. All the other species do become infected, but are rarely killed by the disease. This disease not only affects kangaroo paws. All other members of the family Haemodoraceae and some members of the Iridaceae are also susceptible.

More specific notes on propagation and cultivation

The following report is the result of careful observation and research on the cultivation of plants of this family at King's Park, Perth, Western Australia.

Macropidia fuliginosa The Black Kangaroo Paw

This striking species is known only from areas of heathland north of Perth in Western Australia. Like the other kangaroo paws, its flowers are adapted for pollination by birds. The rich black and green colouration of the flowers, the long curved stamens projecting from the perianth tube, and the branched inflorescence up to 1 m high make *Macropidia* an outstanding showpiece in any native plant garden. However, it is the most difficult kangaroo paw to germinate.



Photography by P. Featherstone

***Macropidia fuliginosa* the Black Kangaroo Paw**

The curious flower is not actually black, the petals and stamens being green but densely covered with black hairs. Readers might forgive the use of this old colour plate but economics are such that expenditure will be made on a new plate when an exceptional photograph becomes available. A plant is shown in the garden on page 201 but this is not a vigorous plant and is past its best.

Macropidia is best propagated in the manner outlined for species of *Anigozanthos*. A few extra points are worth mentioning here.

Very often the seed does not germinate the first year. Bake out in the sun again during the next summer. The seed should germinate the following April. Seed remains viable for at least five years. Experiments with stratification, scarification and the use of chemicals to remove inhibitors have proved inconclusive. Very few viable seeds are found in the bush. A large number of seeds can be obtained by hand pollination.

Pot on seedlings when 5 cm high into 20 cm plastic or polypots, using a mix of 8 parts local grey sand and 1 part cladium peat. A slow releasing fertilizer, such as 12 month osmocote, may also be added. Mulch the pots with laterite. Place the pots in full sun and keep well watered during the winter. Water three times a week during summer. Trickle or hand watering is best, because they cut down the risk of ink disease. Plant out in final positions (or keep in pots) in March/April.

Excessive watering and fertilizing causes lush growth, a large number of aborted flowers and reduces the life span of the plant. You can reduce ink disease by burning the tops of the infected plants in February. As yet, in our experience, no fungicides have proved to be effective in controlling the disease on *Macropidia*.



Photography by R. G. Cooke

***Blancoa canescens*—Red Bugles (Above)**

This is another species of a monotypic genus confined to woodlands and heathlands from Perth northwards. It is distinguished from the closely related *Conostylis* by having red tubular flowers borne in unilateral racemes on a branching scape. A better photograph is in the Horticultural Guide Series Set 5/3.

Blancoa appears to be bird pollinated, in contrast to most *Conostylis* species which are pollinated by bees. See page 199 for flower details.

Cultivation

Grow in a free draining sandy soil in full sun or under very light high overhead shade. Light shade is not recommended for most areas in the Eastern States. The plants may be grown at the usual ground level, or in raised beds, which aids drainage and brings the plants nearer to the eye. *Blancoa* may also be grown in pots for several years, but care must be taken during the summer period. Pots are best plunged during summer to keep in moisture and stop dehydration. The occasional light summer watering may be necessary. *Blancoa* lasts for many years (12+) in cultivation if given the right conditions. Do not water plants during the summer once they are established. Plants are very slow growing in cultivation and usually flower when two years old.

Fertilizers are not recommended, but organics such as blood and bone, or slow releasing inorganics, may be applied lightly.

Propagation from Seed

Good seed is hard to get, but when available it should be sown in the autumn. Germination takes about five weeks and is sometimes erratic. Prick out the seedlings when young into small pots containing a good, open, free-draining sandy mix. The seedlings do not like overhead watering and are prone to damping-off disease.

Cross pollination is essential for good seed production.

Vegetative Division

The rhizomes can be divided. This is best done when the new shoots are only 2 cm high. During the late summer, burn-off the top of your plant (the plant must have been dried off, no summer watering, or this method will kill your plant). Dig up the plant when the shoots are 2 cm high and divide the rhizomes into pieces with 4-5 shoots. Pot on into a good open compost or plant into your garden.

Cutting the foliage off the plant does not have the same results as burning.

Pests and Diseases

Plants are prone to rotting if in poorly drained soil or if watered heavily during the summer. Snails will eat the young new shoots.

Conostylis

Conostylis consists of approximately 35 species endemic in the South West Botanical Province of Western Australia. Most species have yellow bee-pollinated flowers in terminal inflorescences. A few species have a creeping, proliferous habit, forming ground covers a metre or more in diameter (e.g. *C. prolifera*, *C. stylidioides*), while most form caespitose clumps with inflorescences in some cases up to 50 cm high (e.g. *C. robusta*). The genus is common in sand heath and woodlands of the South West Botanical Province, where rainfall ranges from 300-800 mm per annum, but some species are also found in the high rainfall forests of the Darling Range and Lower South West (e.g. *C. aculeata*, *C. setosa*, *C. setigera*, *C. serrulata*).

The taxonomy of the genus has had a troubled history, largely due to an inadequate knowledge of the variability of some species on the part of earlier (mostly European) botanists. The revision undertaken by Dr J. W. Green (1960, Proceedings of the Linnean Society of New South Wales, Vol. 85, pp. 334-373), clarified many problems and provides the most comprehensive treatment of the genus to date. Yet much remains to be done before a satisfactory taxonomic understanding of *Conostylis* is at hand. Research by one of us (S.D.H.) indicates that several undescribed species still exist, and a number of problems concerning the delimitation of intra-specific taxa remain to be resolved. Some recent work on taxonomy and natural hybridisation in the *C. aculeata* group was published in the Australian Journal of Botany, Vol. 25, pp. 395-411 (1977) and in Nuytsia, Vol. 2, pp. 254-264 (1978). This work will be summarised in the next issue.

Cultivation

Grow in a free draining sandy soil in full sun, preferably amongst other plants. A few species will grow in heavier free-draining soils or under light broken shade.

Small tufted species make excellent pot plants, whilst the rapid spreading types such as *C. candicans* and *C. prolifera* are ideal ground covers.

The trend towards using *Conostylis* species as rock garden subjects would provide the ideal situation to overcome the drainage problem in many parts of the Eastern States. It should be remembered that *Conostylis* species do not tolerate severe frosts.

Although few species are in cultivation, those that are grow very well in the home garden situation. The following species are recommended — *C. aculeata*, *C. prolifera*, *C. candicans* and *C. setosa* (the latter prefers light broken shade).

Although fertilizers are not generally recommended, organics (e.g. blood and bone) or a slow releasing inorganic may be applied in moderation.

Once established in the open ground, summer watering should cease or be kept to an absolute minimum to allow the plants their natural dormant period. The photograph on page 201 shows a plant in flower.

Pests and Diseases

The only pests and diseases we have recorded are snails, which attack young seedlings, and a type of ink disease which turns the foliage black when excessive overhead watering is used.

Propagation from Seed

Sow the seed in autumn into a free draining sandy mix. Germination takes about 3-4 weeks. Prick out the seedlings when small and grow on in pots for one year. Further information will be given in the next issue.

Plant out into the garden in the autumn, and make sure the plants receive adequate water until the onset of heavy winter rains.

Cuttings

Species which produce offshoots with stilt-like roots on the end of long stolons can be easily propagated by treating each offshoot as a cutting. Fairly mature plants with developing roots should be used, otherwise the cuttings tend to rot. The plant may be up to three years old before it produces good cutting material.

Vegetative Division

Several species can be divided. Burn off the top of plants in late summer. When the new shoots are 2-3 cm high, divide the plants into pieces with 3-4 new shoots, then pot up and grow on.

***Haemodorum* (Blood Roots)**

This genus consists of approximately 20 species distributed in woodlands and heathlands in mainland Australia, Tasmania and Malaysia. Most species have spindly, erect flowering stems up to 1 m high and bearing small black, red or green flowers in cymes, loose panicles or spikes.

Flower details are given on page 199 and further information can be obtained from the caption to the colour plate on page 209.

Cultivation

Haemodorum species are rarely grown in cultivation in W.A. This may be due to their relatively insignificant flowers.

Grow in a free-draining soil in full sun. These plants are best grown in small clumps amongst shrubs. To add beauty to your garden leave the old flower spike on. The spikes are often used in dry floral arrangements.

Propagation

*Haemodorum*s are easily grown from seed sown in the autumn. Seedlings should be raised in pots for one year. Use a sandy, well-drained soil mixture. Fertilizers are not recommended, but a light application of slow-releasing types may be used if desired.

When the plants are established do not water during the summer dormant period. Bulbs may be lifted and transplanted at the end of the dormant season when first winter rains begin. Plants take two years to flower from seed.

Phlebocarya

This is a genus of three species, all caespitose herbs and all confined to the South West Botanical Province of Western Australia. Each species has small inconspicuous flowers arranged as shown on page 199, in loose cymes.

Unfortunately, we have no data on the propagation or growing conditions required by *Phlebocarya* species, as we have been unable to procure good viable seed despite several attempts to do so.

The sedge-like foliage of *P. ciliata*, and the attractive tomentose, grey leaves of *P. pilosissima*, make these species worthy of future horticultural investigation.

Tribonanthes

This is a genus of five currently recognised species, all endemic in the South West Botanical Province of Western Australia. All species have bulbs and grow in winter-wet swamps or in high run-off areas on the edge of granite rocks. They have white tomentose flowers which are solitary or



Tribonanthes uniflora

Photography by R. Paynter

The flowers of this group of plants differ from others in the family as shown on page 199. The genus is characterised by having each stamen attached as shown on page 199, ending in two yellow, erect, flat appendages above the anthers. The few flowers are always white and appear flannel-like as shown above, because of the dense covering of woolly hairs. The genus differs from other Haemodoraceae in having bulbs rather than rhizomes.

few in number borne on small cymose stems usually 5-30 cm high. While two species (*T. brachypetala* and *T. longipetala*) are well defined and easily recognisable, the remaining three (*T. uniflora*, *T. australis* and *T. variabilis*) are often difficult to distinguish. Further taxonomic work appears necessary to clarify their relationships.

Cultivation

These attractive plants are not widely grown in W.A. This may be due to the short flowering season and to not having the right growing conditions in many areas.

Grow in a soil which is winter-wet but dries out during the summer (e.g. beside a soak or in a low-lying area). Plants grown in Kings Park are many years old but never flower. This may be due to the sandy soil, which is not winter-wet or waterlogged. These plants probably could be grown in pots given the right conditions, namely wet during winter and dry in summer. The pots would be best plunged in sand or soil to stop the bulbs dehydrating.

These plants suffer from a disease resembling the ink spot pathogens of kangaroo paws.



Haemodorum corymbosum Blood Root Lily Photography by M. Hodge

This plant grows in the Townsville area of Queensland and could be mistaken from a distance as *Anigozanthos rufus* or a red form of *A. flavidus*. A report from Townsville reads as follows:

"During the wet summer months, this small lily like plant is common on the outskirts of Townsville where it reaches a height of 1 m. The brick red flowers, held erect on long straight stalks, make this one of the showiest of our local natives. Although it is not yet widely used as a garden plant this small plant should become very popular as more people become aware of it. To provide an effective display it needs to be grown in clumps.

The plant grows easily, if rather slowly, from seed which should be collected at the end of summer. This is the closest east coast relative of the famous Kangaroo Paws from Western Australia. The flowering is improved by encouraging the natural dormancy period in late Winter.'

A report on Western Australian species of *Haemodorum* is not encouraging:

All the *Haemodorum* species from the south west of Western Australia have black flowers that are not especially attractive. However one report mentions red-flowered species from the Kimberley area and more information on these plants is required.

The floral structure of *Haemodorum* is given on page 199 and the yellow anthers thrusting out of the floral envelope or perianth may be seen in the colour plate above.

Anigozanthos—The Cultivation of Kangaroo Paws

The following section provides horticultural details for each *Anigozanthos* species. A report on all the species and descriptions of new species is contained in an article on page 229.

Anigozanthos bicolor

Grow in a free draining soil in full sun. Although this plant grows naturally in winter wet areas, if too wet in cultivation the rhizomes tend to rot. This species has been in cultivation for many years, but people prefer to grow *A. manglesii*, which is similar but has larger stems and larger flowers. See page 236 for a colour plate.

Flower colour does not vary very much, usually being light to dark green with a red base. Yellow and light pink varieties have also been observed.

Anigozanthos flavidus

Grow in a free draining soil in full sun or under light broken shade. This is the toughest of all the kangaroo paws being able to take copious amounts of water during the summer. Plants are long-lived in cultivation and are popular because of the evergreen foliage. Although this plant is usually grown amongst shrubs in borders or in a native garden, it is now very popular in courtyard gardens. The flower colour varies from greenish yellow to yellow, pink, red and orange. See reference on page 200.

Anigozanthos gabrielae

Grow in full sun in a free draining sandy soil. This is an excellent pot plant or rockery plant, which is very floriferous in cultivation, producing many blooms on a very compact plant. This species is usually grown as a biennial, as it tends to be short-lived in cultivation.

The flower colour does not vary very much, being a light to medium green with a red base. See colour plate on page 229.

Anigozanthos humilis

Grow in a free draining sandy soil in full sun. Unfortunately, this species does not grow very well in cultivation and generally only lasts for one or two years. One population north of Perth produces true-breeding golden yellow flowers, which form 2-4 flower-heads on each flower stem. The height of these flowering stems can be up to 60 cm. The plants from this population also live up to six years in cultivation. Flower colour varies from the usual yellow suffused with red to yellow, orange and pink. Most of the plants produce single stemmed flowers, but some populations produce a large quantity of branching stems. Colour plate on page 236.

Anigozanthos kalbarriensis

Grow in full sun in a free draining sandy soil. This species has proved to be very difficult to grow in cultivation. Seed is very difficult to germinate, although little seed has been available. The seed may require a treatment to break dormancy, or it may be that the timing of seed collection is an important factor. See colour plate on page 233.

Flower colour is quite variable, being yellow suffused with red, pale green or golden yellow, always with a red base.

Anigozanthos manglesii

Grow in a free draining soil. The plants are best raised in an open area in full sun, although in the west they can be grown amongst trees with a light broken shade. This is one of the easiest species to germinate and is often grown as a biennial. Within 18 months it is possible to produce a plant with as many as 50 blooms, but usually only 10-15 are produced. In cultivation the plants are short-lived, especially when watered during the summer. Colour plate on cover of this issue, page 197 and page 236.

Flower colour is normally light to dark green with a red base. Other colours include entirely orange, green with an orange base, bright yellow with a red base and metallic blue with a red base. An all white form has also been recorded. See colour variation on page 244.

Anigozanthos onycis

Grow in a free draining soil in full sun. This is one of the most floriferous species in cultivation. When in full flower it is difficult to see the foliage. As well as being a good rockery plant, it also grows well in pots.

The flower has a large perianth tube for the size of plant. Flower colour varies little, being a reddish orange. Colour plate on page 232.

Anigozanthos preissii

Grow in a free draining sandy soil in full sun. The plant may also be grown under light broken shade in Western Australia. If the shade is too heavy the plants will not flower. Although this species has the largest flower of all the kangaroo paws, they are carried on the top of long stems and are therefore best grown amongst other plants to break up the openness

of the stems. In cultivation the plants have been known to survive for at least 12 years. Colour plate on page 109 of Volume 2.

Flower colour varies little, being a light orange.

Anigozanthos pulcherrimus

Grow in a free draining soil in full sun. This is a very good summer flowering plant which is extensively used as a cut flower, both fresh and dried. The flowers appear from late November to February. Flowering depends a lot on the weather. During a heatwave the flowers are often badly burnt.

Flower colour varies from the usual golden yellow or apricot to yellow with a reddish coloured flowering stem as on page 109 of Volume 2.

Anigozanthos rufus

Grow in a free draining sandy soil in full sun. An exceptionally good plant for cultivation. The flowers contrast well when grown with *A. pulcherrimus*. The cut flowers are used extensively either fresh or dried.

Flower colour varies little from the usual red, although pure yellow forms have been recorded. See colour plate on page 200.

Anigozanthos viridis

Grow in a free draining soil in full sun. Although this plant grows in winter-wet areas, it grows exceptionally well in sandy soils. This species has been in cultivation for many years and is a good garden plant which is best grown amongst small shrubs as long as the plant is in a fairly open position.

The flower colour varies from light green to dark green. Yellow and pink forms have been recorded.

This concludes a general introduction to the family Haemodoraceae and general information on the cultivation of these plants. One of the authors, S. D. Hopper will now report on experiments in hybridisation of species to produce plants of horticultural value. On page 223 he also reviews developments in the taxonomy (botanical naming) of *Anigozanthos* and describes new species only recently formally named. ■

Hybridizing Anigozanthos

By **STEPHEN D. HOPPER**

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Introduction

The genus *Anigozanthos* consists of 11 species of perennial herbs, commonly known as kangaroo paws, which are endemic in south-western Australia. All species appear to be bird-pollinated and produce richly pigmented flowers on stems which range in height from 10-20 cm in *A. gabrielae* to in excess of 3 m in *A. flavidus*.

Because of their unusual floral structure and striking colouration, the kangaroo paws have attracted considerable horticultural interest (Beard, 1963; Grieve and Marchant, 1963; Newby, 1970; Oliver, 1971, 1972; Lullfitz, 1978). Attempts to bring the species into cultivation have met with varied success. Only *A. flavidus* has proved to be easy to germinate and grow vigorously in cultivation. Most of the other species are more difficult to germinate and most are relatively short-lived in cultivation, being susceptible to snail attack and a fungal disease known as inkspot. For example, I planted 10 seedlings of *A. flavidus*, 10 of *A. manglesii* and 15 of *A. humilis* in my garden early in 1977. Two years later the 10 *A. flavidus* were alive and thriving, whereas all the *A. humilis* and 9 of the 10 *A. manglesii* had succumbed within 12 months of planting.



Anigozanthos preissii x *A. flavidus* F. Hybrid



Anigozanthos onycis x *A. flavidus* F. Hybrid

Although *A. flavidus* has attractive lemon-yellow flowers, and red, pink and orange individuals occasionally may be found, its colours are no match for the vivid hues of the other species of *Anigozanthos*. Accordingly, interest has been shown in the hybridisation of *A. flavidus* with other species in the hope that hybrids may be produced which combine the good germination rate, the vigorous foliage and the resistance to snail and fungal attack of *A. flavidus* with the rich floral colouration of its attractive relatives. Oliver (1971, 1972) has reported some successes along this line, but indicated that more work was required to realise the full horticultural potential of these interspecific hybrids.

In the course of studies on the evolution, ecology and natural hybridisation of kangaroo paws (Hopper, 1978), I conducted an extensive interspecific crossing programme and successfully raised to flowering 39 different kinds of interspecific hybrids. Those which had *A. flavidus* as one of their parents have proved to be the longest-lived and the most suitable as garden plants. This article aims to compare and contrast the 10 different interspecific hybrids of *A. flavidus* in terms of their ease of synthesis, germination, pollen fertility and performance in a Perth garden situation.

Synthesis, Germination and Pollen Fertility of the Hybrids

Interspecific hybridisation was undertaken in spring by hand pollination in an enclosed glasshouse. An enclosed area was required to prevent contamination of controlled crosses by honeyeaters. *A. flavidus* was found to set abundant seed on self-pollination, while all other species set very few. Consequently, to avoid contamination of crosses by self-pollination, *A. flavidus* was always used as the pollen parent in controlled pollinations. Pollinated flowers were immediately labelled with watchmakers' tags, and fruits were harvested some 3-5 months later when signs of dehiscence were first evident. Individual fruits were dissected and the number of plump mature seeds counted.

Seed set was found to vary considerably between different *Anigozanthos* species on hybridisation with *A. flavidus* (Table 1). On average *A. bicolor* set the highest number of seed per fruit (44). *A. viridis*, *A. gabrielae*, *A. onycis* and *A. kalbarriensis* each set between 10 and 20 seeds per fruit, while the remaining six species all averaged less than 10. *A. rufus* and *A. pulcherrimus* set the lowest number of seeds recorded in the study, averaging 1.6 and 1.5 respectively. All species set significantly fewer seeds on hybridisation with *A. flavidus* than they do on crossing with conspecific individuals.

To test for germination the first autumn after fruit harvest, seeds were preheated for two hours in a waterbath at 55-60°C and immediately sown

Anigozanthos preissii x *A. flavidus*—F. Hybrid (top left)

One of the most attractive hybrids so far produced. It is a narrow-leaved plant with erect flowering stems up to 1.5 metres high bearing double-headed clusters of large orange flowers. The plants have the highest pollen fertility of any of the interspecific hybrids of *A. flavidus* and therefore have potential for the plant breeder. The difficulty in illustrating this work adequately is shown here where an attempt to show flower detail and colour has failed to present the full impact of the plants.—Photography and comments by S. D. Hopper.

Photography by S. D. Hopper

Anigozanthos onycis x *A. flavidus*—F. Hybrid (bottom left)

This is a compact plant with stems 50-80 cm high and large orange flowers. It is one of the few hybrids that is not completely pollen sterile, and therefore has potential for the plant breeder to develop horticulturally desirable lines. *A. onycis* is a species only recently described and is found in disturbed habitats of the Stirling Range—Bremer Bay area. The flowers are up to 5 cm long growing on stems 15-30 cm high. The hybrid plant pictured has the character and colour of the *A. onycis* parent but is increased in size and hopefully in vigour and headiness by the *A. flavidus* parent.

Anigozanthos manglesii x *A. humilis* (see page 236)

Anigozanthos rufus x *A. flavidus*—F1 Hybrid

Refer to page 200 for the colour plate of this hybrid shown growing next to one of its parents *A. rufus*. These photographs will give some indication of what is being achieved by hybridization trials.

in a soil mixture of 12 parts fine sand, 6 parts coarse sand, 1 part loam and 4 parts sheep manure/compost. Seed pots were maintained in a glasshouse under a daily watering regime, and the number of seedlings scored 80-100 days after sowing.

Table 1

Average number of seed set/fruit, average percent seed germination and average percent pollen fertility of *F.* hybrids in *Anigozanthos* following controlled interspecific pollination with *A. flavidus*. Sample sizes of fruits, seeds and hybrids are given in parentheses after their respective averages. Data are from Hopper (1978).

<i>Anigozanthos</i> Species crossed	No. seed set/fruit	Germination	F ₁ hybrid pollen fertility
<i>onycis</i> x <i>flavidus</i>	13.8 (36)	12% (368)	22.1% (9)
<i>preissii</i> x <i>flavidus</i>	9.3 (29)	7% (200)	42.5% (3)
<i>rufus</i> x <i>flavidus</i>	1.6 (30)	29% (49)	2.9% (3)
<i>puicherrimus</i> x <i>flavidus</i>	1.5 (12)	0% (18)	—
<i>manglesii</i> x <i>flavidus</i>	6.5 (16)	39% (100)	0.1% (8)
<i>viridis</i> x <i>flavidus</i>	17.3 (36)	27% (400)	0.0% (3)
<i>bicolor</i> x <i>flavidus</i>	43.9 (36)	61% (500)	1.8% (6)
<i>gabrielae</i> x <i>flavidus</i>	15.4 (5)	52% (77)	1.6% (9)
<i>humilis</i> x <i>flavidus</i>	8.3 (30)	0% (100)	0.8% (2)
<i>kalbarriensis</i> x <i>flavidus</i>	12.0 (15)	61% (100)	0.9% (16)

Germination rates were found to be variable between pots for the one cross and variable between different crosses. As shown in Table 1, on average 50-60% of seeds of *A. bicolor* x *flavidus*, *A. gabrielae* x *flavidus* and *A. kalbarriensis* x *flavidus* germinated. No germination was recorded for *A. humilis* x *flavidus* and *A. puicherrimus* x *flavidus*, but only a small number of seeds were available for testing in these cases, and other workers have successfully germinated these hybrids (K. Oliver and R. Dixon pers. comm.). The remaining *A. flavidus* hybrids showed 7-39% average seed germination. The *A. bicolor* x *flavidus*, *A. gabrielae* x *flavidus*, *A. kalbarriensis* x *flavidus* and *A. rufus* x *flavidus* hybrid seeds showed a large improvement in germination in comparison to their maternal parents, while the remaining hybrids germinated at a comparable or lower level to that recorded for their maternal parents (Hopper, 1978).

To estimate pollen fertilities, seedlings were repotted 3-4 months after sowing and grown to reproductive maturity in the glasshouse or experimental garden under a similar soil and climatic regime to that used during the germination trials. While a small proportion of hybrids flowered within nine months of sowing (i.e. before summer), the majority required 18 months to reach maturity.

Buds were collected from each hybrid just before anthesis. A fresh anther was removed from each bud and dissected in a drop of aceto-carmin on a microscope slide. After positioning an 18 mm² coverslip, the slide was scanned along edge to edge transects at 400 x magnification until 100-800 pollen grains had been scored as being normal in shape with pink-stained cytoplasm (assumed to be fertile), or shrivelled and devoid of cytoplasm (assumed to be sterile).

All hybrids showed substantial reductions in pollen fertility relative to the 90% + fertile grains normally encountered in the parental species (Table 1). Hybrids of *A. preissii* x *flavidus* and *A. onycis* x *flavidus* were the most fertile, averaging 42.5% and 22.1% good pollen respectively. All other hybrids averaged less than 3% fertile pollen, and some appeared to be completely sterile (e.g. *A. viridis* x *flavidus*). These figures suggest that propagation of hybrids through seed production would only be likely with hybrids of *A. preissii* x *flavidus* and *A. onycis* x *flavidus*.

Horticultural Characteristics of the Hybrids

To assess the performance of the various hybrids in a garden situation, seedlings were planted in sandy well-drained soil in my home garden at East Victoria Park in May, 1977. Over the subsequent two years observations were made on 37 hybrids, including four *A. gabrielae* x *flavidus*, seven *A. kalbarriensis* x *flavidus*, eight *A. manglesii* x *flavidus*, two *A. viridis* x *flavidus*, four *A. bicolor* x *flavidus*, five *A. onycis* x *flavidus*, three *A. preissii* x *flavidus* and four *A. rufus* x *flavidus*. These plants were not fertilised or protected from snail attack. Water was applied every second day over summer.

It was found that the colour and vigour of the foliage of *A. flavidus* was dominantly inherited in all hybrids. Accordingly most plants were far less susceptible to snail and fungal attack than their maternal parents (Table 2). *A. rufus* x *flavidus* hybrids were particularly resistant in this regard. Considerable variation in resistance was noted between hybrids of the same cross. For example, of two adjacent plants of *A. manglesii* x *flavidus* observed at the end of the 1978 winter, one had lost 75% of its foliage to snails and inkspot disease, while the other had lost 10% of its foliage. Similar striking differences were recorded between plants of *A. bicolor* x *flavidus*, *A. gabrielae* x *flavidus* and *A. kalbarriensis* x *flavidus*. This variation in resistance would appear to be inherited, since adjacent plants grown under identical conditions often differed considerably. Hence there would appear to be some scope for selective plant breeding in any large-scale work on the propagation of these hybrids.

Table 2

Estimated percentage of foliage of various *A. flavidus* hybrids that had succumbed to snail attack and inkspot disease at East Victoria Park during the winter of 1978.

Hybrid	Snail attack	Inkspot
<i>onycis</i> x <i>flavidus</i>	0-5%	1-5%
<i>preissii</i> x <i>flavidus</i>	0-5%	5%
<i>rufus</i> x <i>flavidus</i>	1-5%	1%
<i>manglesii</i> x <i>flavidus</i>	1-75%	1-75%
<i>viridis</i> x <i>flavidus</i>	0%	5-10%
<i>bicolor</i> x <i>flavidus</i>	1-50%	5-30%
<i>gabrielae</i> x <i>flavidus</i>	0-10%	10-75%
<i>kalbarriensis</i> x <i>flavidus</i>	10-50%	10-90%

Because of their vigorous vegetative growth, most hybrids developed into bigger plants than their maternal parent species. Table 3 gives maximum foliage cover, leaf length, leaf width and stem height recorded on two-year-old hybrids in my garden. *A. rufus* x *flavidus* were the largest hybrids and produced the tallest stems (up to 1.6 m high), while *A. kalbarriensis* x *flavidus* formed the smallest clumps and usually had stems only 20-30 cm high. None of the hybrids attained the height and size of *A. flavidus* itself.

A range of plant forms were found among the various hybrids. Some had large broad-leaved clumps producing a mass of branched flowering stems as broad as they were high (*A. rufus* x *flavidus*, *A. manglesii* x *flavidus*). Others produced long but slender leaves, and flowering stems that were much taller than they were broad (*A. preissii* x *flavidus*, *A. viridis* x *flavidus*). At the other end of the spectrum were small compact plants with short broad leaves and short but densely flowered stems (*A. kalbarriensis* x *flavidus*).

In 1978, *A. gabrielae* x *flavidus* hybrids were the first to flower, some producing stems early in July. Most other hybrids did not commence flowering until late September. *A. preissii* x *flavidus* flowers were the last

to appear, with blooms finally opening in November. Although most hybrids finished flowering by the end of January, flowers of *A. rufus* x *flavidus* continued to open until the end of February. Thus the garden had spectacular displays of hybrid flowers for eight months of the year. Individual plants, particularly of *A. rufus* x *flavidus* and *A. gabrielae* x *flavidus*, produced new flowers for up to five months.

Estimates of the total number of flowers appearing on the various hybrids are given in Table 4, together with average numbers of stems per plant, inflorescences per stem and flowers per inflorescence. Data obtained from five *A. flavidus*, two *A. pulcherrimus* and one *A. rufus* in the same garden are also given.

Table 3

Maximum diameter of foliage cover, maximum leaf length and width, and maximum flowering stem height of two-year-old *A. flavidus* hybrids at East Victoria Park.

Hybrid of <i>Anigozanthos</i> species	Foliage cover diameter (cm)	Leaf length (cm)	Leaf width (mm)	Stem height (cm)
<i>onycis</i> x <i>flavidus</i>	45-55	24-26	9-10	50-80
<i>preissii</i> x <i>flavidus</i>	50-70	26-47	6-8	90-100
<i>rufus</i> x <i>flavidus</i>	75-120	36-60	11-14	140-160
<i>manglesii</i> x <i>flavidus</i>	70-75	40-45	12-13	80-140
<i>viridis</i> x <i>flavidus</i>	—	—	—	80-90
<i>bicolor</i> x <i>flavidus</i>	40	18	10	70
<i>gabrielae</i> x <i>flavidus</i>	25-50	11-19	10-11	50-70
<i>kalbarriensis</i> x <i>flavidus</i>	30-40	13-20	5-9	20-50

Table 4

Average number of flowers per inflorescence, inflorescences per stem, stems per plant and estimated average total flower number per plant recorded on *A. flavidus* hybrids, *A. flavidus*, *A. pulcherrimus* and *A. rufus* at East Victoria Park at the end of 1978 flowering season.

Plants	Flowers per inflorescence	Inflorescences per stem	Stems per plant	Flowers per plant
<i>onycis</i> x <i>flavidus</i>	7.7	6.1	15.3	719
<i>preissii</i> x <i>flavidus</i>	7.0	5.1	9.0	321
<i>rufus</i> x <i>flavidus</i>	13.7	11.8	47.0	7,598
<i>manglesii</i> x <i>flavidus</i>	12.1	5.6	23.9	1,532
<i>viridis</i> x <i>flavidus</i>	5.7	4.5	11.5	295
<i>bicolor</i> x <i>flavidus</i>	8.0	5.3	22	933
<i>gabrielae</i> x <i>flavidus</i>	15.8	2.1	28.3	939
<i>kalbarriensis</i> x <i>flavidus</i>	6.4	2.9	59.4	1,103
<i>A. flavidus</i>	7.0	13.4	22.2	2,082
<i>A. pulcherrimus</i>	9.9	10.3	13.5	1,378
<i>A. rufus</i>	6.5	10.2	24	1,591

A. rufus x *flavidus* hybrids were outstanding in the number of flowers produced, averaging 7,600, five times as many as pure *A. rufus* and almost four times as many as pure *A. flavidus*. *A. manglesii* x *flavidus* hybrids were a relatively poor second in flower production, averaging 1,500 per plant (some 530 less than that recorded for pure *A. flavidus*). However, this number greatly exceeds normal levels in wild populations of *A. manglesii*,

where on average only 50 flowers per plant are produced (Hopper, 1977). All other hybrids had less flowers than the number found on *A. flavidus*, but all produced far more than the number typical for their maternal parent species. For their small size, *A. kalbarriensis* x *flavidus* and *A. gabrielae* x *flavidus* had very large numbers of flowers.

Floral colours were often variable for any one class of hybrid, particularly in the case of *A. kalbarriensis* x *flavidus* and *A. manglesii* x *flavidus* (see Oliver, 1971, for illustrations of colour variants of the latter). *A. rufus* x *flavidus* plants were particularly handsome with their rich burgundy flowers. *A. preissii* x *flavidus* plants had large attractive orange flowers, while *A. onycis* x *flavidus* had an orange-pink hue. The flowers of *A. viridis* x *flavidus*, *A. bicolor* x *flavidus* and *A. gabrielae* x *flavidus* were an unattractive dull green, but better colours would probably be obtained if a prudent choice of brightly hued parental plants was made.

Conclusion

Hybrid seed can be successfully obtained and germinated from flowers of all *Anigozanthos* species on controlled pollination with *A. flavidus*. All hybrids inherit the foliage characteristics of *A. flavidus*, including vigorous growth, resistance to snail attack and resistance to fungal infection. However, these characteristics are inherited to varying degrees, and some selection would be required for any large-scale propagation of the hybrids.

The various hybrids show a range of plant forms from small compact tussocks to very large plants almost equal in size to *A. flavidus* itself. The hybrids also show considerable variability in flower production and flower colour. *A. rufus* x *flavidus* is outstanding in the number of flowers it produces.

Although most of the hybrids approach full pollen sterility, *A. preissii* x *flavidus* and *A. onycis* x *flavidus* are sufficiently fertile to have some potential for plant breeding through normal sexual reproduction. Propagation of lines of most of the other hybrids can be carried out on a small scale through vegetative division, but any large-scale ventures would do well to concentrate on either the synthesis of fertile polyploids (Oliver, 1971) or else on tissue culture (Anon., 1978).

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Good Forms of True Species

There is no doubt that the work of competent scientists who are also horticulturalists, such as that of Stephen Hopper is valued and necessary. Those who have been fortunate enough to see good forms of the true species will no doubt agree also with the statement that development from the very best forms could produce exceptional plants of unrivalled beauty. We need to select from the very best forms, have them identified by some means, a cultivar name seems the best way, grow these, select from the best progeny, grow from these, select from the best progeny, etc., etc., etc.

The other line of research is to plan, observe and record cultivation methods, growing medium, plant nutrition systems, root stock care and above all to communicate. For these reasons I especially commend the work of the following writers. T. S. Broxton and the late P. S. Mims for root stock care and cultivation, Jim Webb for what could possibly be vital research and the writer in the Division Of Soils of the CSIRO together with Dr. A. Smith of Australian Plants No. 73, page 209.

Notes On Propagation and Cultivation of Kangaroo Paws

from T. J. Bronxton, Eltham, Victoria.

Kangaroo Paws, i.e. *Anigozanthos* species, as well as *Macropidia*, *Pater-sonia*, *Diplarrrena* and *Calectasia*, are propagated most readily by root division. Seed of *Anigozanthos* is slow growing, slow to flower and, for *A. flavidus* and its hybrids, the colour is not reliable.

I have successfully used my method of propagation by root division on the Red and Green Kangaroo Paw, *A. manglesii*, *A. flavidus*, *A. pulcherrimus* and *A. rufus*. The plants are generally lifted out of the soil with a spade, and any adhering soil is shaken free. Then the rhizome is cut with a sharp knife into two approximately equal pieces. Individual pieces for each new plant are then cut off the rhizome with the knife, making sure that there is at least two cubic inches of rhizome per plant. The attached fibrous roots are then removed with seccateurs and the piece is cleaned with water. The leaves are trimmed to about 8-10 cm. Any stumps remaining from old flowers are removed as close to the rhizome as possible. The raw ends exposed by cutting are not specially treated.

The potting medium consists of three parts of propagating sand plus one part of a 1:1 mixture of Cranbourne loam and mountain soil. To the complete mix is added 5-10% of peat moss or vermiculite, and a complete fertiliser, rich in phosphate and potassium. This open well-drained mix is especially important for *A. pulcherrimus*, *A. rufus* and for *Macropidia* sp.

Pots should be initially in partial sun, with some shade from the heat of the day and shelter from drying winds.

Cultivation in Victoria

Unfortunately the natural soil in much of the Melbourne metropolitan area is clay, and with the exception of *A. flavidus* and its hybrids most *Anigozanthos* species will not survive in this type of soil. It seems to be necessary to provide sandy, well-drained beds, preferably in open, sunny areas. I have had success with *A. manglesii*, *A. rufus*, *A. pulcherrimus* and *A. flavidus* in a sandy bed consisting of a 50/50 mixture of mountain soil and coarse washed sand to a depth of 1 m. *Macropidia fuliginosa* has also grown well in this bed for a number of years. All of these paws have flowered well, and *A. manglesii* forms a vigorous clump after about two years provided regular summer watering is maintained. A vigorous clump of *A. manglesii*, with about 30 flower spikes, is a spectacular sight indeed. Limited success has also been achieved in a more shallow bed (30 cm) at the top of a slope. *A. rufus* grows well under these conditions, but I have only had about a 50% success rate with *A. manglesii* over a two-year period in this bed.

In my experience ink-spot disease is not a problem, because I treat my plants with Bordeaux mixture at least twice a year, usually in the spring and autumn. This means that plants scheduled to be divided the following February-April have had a dose of Bordeaux the previous September.

Growing Kangaroo Paws in Melbourne

from the late P. B. Mims, Victoria.

Notes prepared and previously published in the hope that others will carry on.

I first concentrated on the control of a black smut, often called ink disease, and spent considerable time and money on fungicidal sprays, with very disappointing results — possibly because the plants were promptly re-infected by airborne spores usually present in our climate.

Yeast. (refer Australian Plants, Vol. 4, Page 179). I have satisfied myself, by comparing treated plants with untreated control plants, that this treatment shows a definite improvement — unfortunately my lack of chemical knowledge prevents my understanding of just what occurs. What are the changes that take place in yeast, sugar, starch, and alcohol, and what effect do these have on the ecology of the fungi, bacteria, and insects, which cause our ink disease trouble?

Cultivation of Strong, Healthy Plants

Plants able to thrive under my local conditions seem to require:

(1) Drainage

I have read that in W.A. both *A. viridis* and *A. bicolor* will grow in swamps. They will not with me -- perhaps due to our summer rain and our garden hoses? All species require good drainage here.

(2) Acidity

Each species probably has different acidity requirements, but even the species most tolerant of soil conditions, *A. flavidus*, improves with an acid soil. When a *A. flavidus* rhizome was transplanted from a neutral soil (pH 7) to a pH 4 soil it next year showed much brighter flowers and much less ink on the tips of the leaves.

(3) Protection from Insects

Every insect in my garden (both Aboriginal and New Australian) loves to eat my kangaroo paws. I always actively encourage birds and discourage cats but surface insects are now a very minor problem. It is the other insects which are my greatest problem. I have seldom dug up a dying kangaroo paw plant without being able to find a cutworm, wireworm, or somesuch at the roots — and the presence of nematodes (both foliar and root knot nematodes) has been confirmed for me by the Victorian Agriculture Department at Burnley. Just what is the control?

(4) Dormancy

Each species seems to have its own requirements, but an annual rest period appears to be essential to the less hardy species, and does no harm to the more robust species. This gives a respite from the attacks of bacteria, fungi, and insects, and a holiday from the hazards of our summer rain and our garden hoses. It also simplifies pest control. I am now lifting the rhizomes (like European bulbs and rhizomes) as soon as the plants start to shrivel — shake off the surplus soil — dust with soil insecticide (D.D.T. and Copper Oxychloride) and store in a dry shed. When the season changes (usually about Easter here) they are ready to divide and plant out.

Anigozanthos humilis seldom survive with me without lifting. *A. bicolor* survival rate is greatly increased by lifting. *A. viridis* will often survive if left, but is improved by a holiday. *A. manglesii* has a factor which I do not understand. Most fail to survive after one season, but I have several plants now six years old which have not been dried out, although replanted in different positions each year. I understand that this species has the largest range of any in W.A. I have no means of knowing from where seed comes — possibly plants from different localities have different dormancy requirements?

Anigozanthos—Calcium Deficiencies?

From Jim Webb, author of the following article presenting vital original research that could preface a new approach to the cultivation of Australia's wildflowers.

Kangaroo Paws are one of the groups of plants that are responding to applications of calcium in both increased growth, better appearance and increased frost resistance on low calcium status soils.

With the increase in growth comes better flowering and longer flower stems. The better appearance comes from the decrease in and eventual elimination of the blackening and withering of leaf tips, which often appears to be the symptoms of calcium deficiency rather than the more universally blamed "Ink Disease".

With frosting, the leaves are at first "browned" and these affected leaves then become gradually blackened as the killed tissue dehydrates. Supplied with adequate calcium the following species will survive to -4.0°C without damage: *Anigozanthos flavidus*, *A. manglesii*, *A. viridis*.

In the same soil without calcium these species are often fatally frosted. Observations and experiments have not been conducted with the other *Anigozanthos* species.

The Role of Calcium in the Cultivation of Australian Plants

by J. H. WEBB

Introduction

In the early days Australian plant growing took place exclusively overseas, whilst here our efforts were directed towards establishing exotic plants. Seed was sent from all over Australia — N.S.W., Tasmania, Western Australia and Queensland, to be grown overseas in soil mixes in hot houses and at that time, differing lime requirements were acknowledged.

The earliest recorded growers of Australian plants were the English gardeners at Kew and similar establishments, and they freely advocated the use or the deletion of chalk whichever they found necessary as in 1834 when chalk was used in the growing of *Anigozanthos manglesii* in England. (1)

In contrast in Australia, even as far back as 1904, when J. H. Camfield wrote in the *Agricultural Gazette* of N.S.W. on the cultivation of natives, its use was not discussed, (2) although at the time the use of lime featured strongly in current horticultural practice.

More recently lime or other forms of calcium have not generally been recommended for use with the cultivation of Australian plants. In fact its use has been contra-indicated or the subject was not mentioned by recent authors when discussing the growing of natives.

Almost a century passed after the early English growers before the modern wildflower growing movement got under way in the 1930's and the pioneers of that period were primarily bush walkers and naturalists. In N.S.W. for instance, members of the Sydney Bushwalking Club were very active in the areas covered by the Hawesbury Sandstone Flora, and having seen the plants flourishing in the native habitat were keen to grow them in their own gardens. These gardens were often limed for exotic plants such as roses, and they were soon able to spot the calciphobic nature of most of the sandstone flora.

From groups such as this came our first expert growers and by word of mouth and later in print they quite rightly advocated no lime for the local plants then in cultivation. Post-war the number of species grown increased beyond the local plants, and for the last decade or so has included many Western Australian plants. The blanket ban on lime persisted however, indeed it was not readily apparent that some of the new natives needed added lime to survive, nor that the same amount of applied lime caused other species to suffer badly from lime induced iron deficiency — causing severe chlorosis and necrosis of growing points. This phenomena probably created a larger number of apparent anomalies in the use of calcium.

Horticultural Usage

In June 1795, I first put forward the hypothesis of lack of calcium being one of the major causes of failure of certain West Australian plants when grown in the east. (3) (4) Since that time I have conducted many more trials and have received many reports that confirm the beneficial effects of added calcium. There has also been the odd expression of disbelief, and there have been failures which may be attributable to interaction with phosphorus.

I have received information that even on the Perth Sand Plain extra calcium is needed with some species for optimum growth. In some eastern areas survival only has been achieved, and here other factors such as bad drainage or aeration may be interacting. In Sydney at Castlecrag, flowering has been achieved for the first time in that area by calcium additions to *Chamelaucium uncinatum*. (5)

A further refinement in the cultivation of calcium responding species of the family Proteaceae is to add an acid surface mulch, (preferably local peat) to the lime enriched soil. This layering encourages the development of proteoid roots in the peat layer. Growth is healthy and better than with the straight lime treatment. Peat layering in the absence of calcium gives

little response, both controls and peat treatment ending with the death of the plants.

The safest method of applying calcium is in the use of slow release materials, the quantites per plant can be as high as 10 kg. and can be in any of these forms, limestone gravel, shells (sea or egg), cement or calcined bone. Ground carbonate of lime as used in agriculture can be used but care needs to be taken with rates of application.

For example, rates of application of up to 80 tonnes per hectare or 63 grammes (2 heaped dessert spoons) per 10 cm pot, or 8 kg. per sq. metre of agricultural lime can be applied to calcium responding plants, and they will respond well to these levels at first but later growth will be dwarfed with no other adverse symptoms. Such dwarfing effect may improve the plants' horticultural value as flowering is often not affected, and the plant is visually more attractive. Many examples of this dwarfing phenomena I am sure, exist in the field situation. One example is the *Banksia grandis*. On the Perth Sand Plain it will become a tree 4-5 m in height. The same species grows as shrubs to 1 metre on southern coastal limestone.

A second example is where shallow top soil overlies limestone. Here *Pimelea ferruginea* grows in dwarf form on road verges cleared of scil, whereas the normal plants occur on adjacent undisturbed sites. A genetic factor could be involved in the former but perhaps not in the latter.

There may be other factors involved, but I am sure that such marked lime effects can be exploited, especially for container grown plants. When I have substituted Magnesium Carbonate for Calcium Carbonate* (4) the resulting pH levels were similar. In contrast substitution with Calcium Sulphate (gypsum) at equivalent calcium levels did not change pH, and growth compared with controls was not as great as when the carbonate form was used. Even twice the level of CaSO_4 was still not as effective as the carbonate. This indicated that the calcium response was probably related to pH effect.

To separate calcium effects from pH effects completely is a difficult task. I believe this would be possible using water culture experiments that involve constant filtration adjustments of the medium, extending over many months. This is now possible with available automated laboratory equipment but as I do not have the resources, perhaps someone with these facilities may like to follow this up. Results of a subsequent experiment that I present in this paper suggest that the calcium effect may be largely independent of the pH effect. Garden practice however, is to use enough ground limestone* to take the pH to neutral, and then add a large amount of slow release calcium. This appears to be working satisfactorily.

Some of the group of Australian plants that respond to calcium and which includes many West Australian species, die off whether treated with applied calcium or not.

Which brings me to the question, what caused their death? Phytophthora is the answer most often given.

Fluctuating water supply is another suspect. Frost or lower temperatures is often blamed in some areas.

* Calcium is available in a number of forms suitable for garden usage; solubility determines the degree of care that is needed to apply various forms. For example, quick-lime Calcium Oxide is too caustic and soluble to be used at all as a soil additive. The next form, slaked-lime Calcium Hydroxide, can be purchased as builders' lime and can be used, but at low levels only. The normal application is agricultural lime, which is ground limestone (Calcium Carbonate). This normally contains a number of different size grindings; the fine dust is more soluble than the coarser, longer lasting particles when it is incorporated in the soil. The other sources are cement (care needed with this one also unless it has set), Concrete, sea-shells, egg-shells, limestone gravel, gypsum and dolomite — the latter containing Magnesium Carbonate as well as Calcium Carbonate. All these other sources have varying degrees of solubility, and as such can be considered as slow release forms and which, depending on quantity applied, will not change the pH as suddenly as the more soluble forms, and therefore the amount applied is not as critical.

1. *Phytophthora*

Calcium in my experience, does not completely prevent death by *Phytophthora*. However, increased vigour and root growth attributable to applied calcium does act in reducing the effect of infestation, in comparison with untreated plants. I doubt whether the existing tendency to claim that if *Phytophthora* is isolated from, on or near the corpse, it was the cause of death. As *Phytophthora* can be isolated from around healthy plants and from soils almost everywhere, some species whether lime treated or not, will succumb to the fungus usually in circumstances of poor drainage.

As a preliminary investigation, I am growing *Hardenbergia violacea* and *H. comptoniana* in combination with susceptible *W.A. Banksia* species. Root exudates from legumes are reputed to inhibit *Phytophthora*, but I have no suggestion to offer as yet about mixed plantings and calcium application.

2. Fluctuating Water Supply

This could be the cause of death of some plants whether calcium treated or not, although the effect could be difficult to establish. The problem is compounded by the probable presence of *Phytophthora*. Certainly with calcium enrichment there is a lower mortality in container grown plants receiving regular watering than in open situations prone to water fluctuations. Control plants without calcium die off equally whether in pots or in open ground.

As calcium is largely immobilised within the plant any calcium dependent growth effect will very likely depend on calcium uptake from the soil. If calcium and water uptake are linked, water relationships, between the soil and plant assume greater importance in calcium studies.

3. Frost Resistance

In contrast to the last two factors I have experimental results and supporting field observations showing that a calcium responsive plant exhibits increased resistance to frosts when supplied with adequate calcium. The plant is *Ficus rubiginosa* the Port Jackson Fig.

This plant is naturally distributed in the coastal areas of Queensland and New South Wales, extending into the tableland areas by way of coastal valleys. I will refer only to the disjunct distribution in the Central and Southern Tablelands, to illustrate my points.

It is generally accepted that *Ficus* forms part of the Indo-Malaysian element of the Australian flora. Increasing cold would be a barrier to their wider natural distribution both southwards and inland from the coast. Numbers of plants decline when moving towards a more southerly latitude and also decrease in numbers with increasing altitude. This decline in numbers is not related to lack of available moisture because precipitation increases south of their limit of distribution.

With *Ficus rubiginosa* the southernmost occurrence recorded is at Eden, N.S.W., but I have been unable to locate the single tree involved. I fear that like a lot of rare occurrences, man's unthinking activities have caused its loss.

The occurrence in the coldest location is at Bendethera, inland in the mountains from Moruya N.S.W., at about 600 m altitude and less than 10 kilometres from mountains of 1670 m. Here three known specimens are surviving confined to a narrow limestone belt. It was from the largest of these trees that the main experimental material was obtained.

The main conclusion from the experiment is that in the calcium sensitive *Ficus rubiginosa* frost resistance and calcium levels are related. This explains some aspects of the North-South distributions in Eastern Australia. I am proposing that in all of the southernmost occurrences of *Ficus rubiginosa* its disjunct distribution is related to a high readily available level of calcium

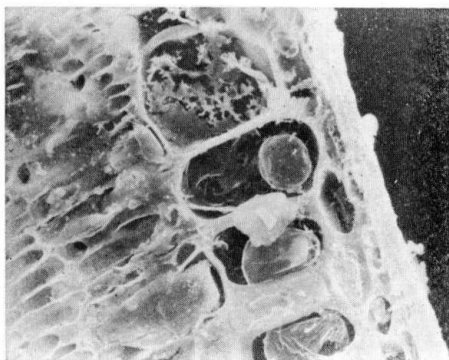
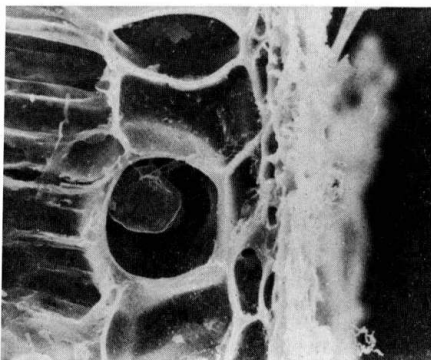
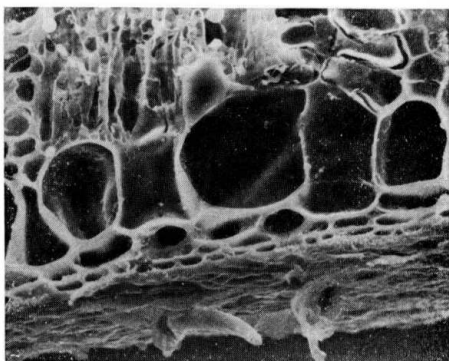
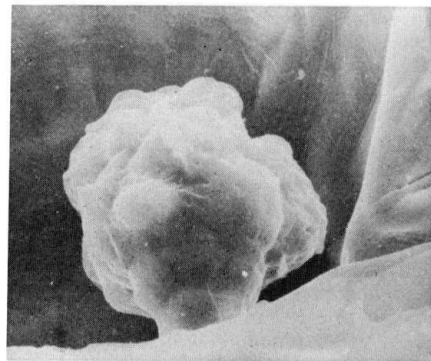


Fig. 1—Cystoliths or calcium deposits in a leaf of *Ficus rubiginosa*

Fig. 1(a), top left—A typical growth in a leaf cell magnified 100 times.

Fig. 1(b), top right—A cross section of a leaf without cystolith growths.

Fig. 1(c), bottom left—A cross section of a leaf with few cystolith growths.

Fig. 1(d), bottom right—A cross section of a leaf with a high cystolith count.

in the root zone, and that the absence of intervening occurrences are probably due to lower levels of calcium not protecting the plants from frosting. In more northerly sites these same levels permit more widespread occurrences. Below a certain level of calcium the plants cannot occur irrespective of the warmer temperatures.

In all cases the cold tableland occurrences are on high calcium status rocks and soils, such as basalt, and limestone. A typical analysis of southern basalt soils gives a reading of 11% of calcium expressed as oxide. One anomalous occurrence of *Ficus rubiginosa* appeared related to its distribution in the Hawkesbury sandstone areas. Here, on the low calcium status sandstone soils, *Ficus rubiginosa* occurs in two sites;

1. in gullies with or without rainforest,
2. on or at the bottom of sandstone cliffs (lithophytic occurrences).

In gullies, otherwise low levels of alkaline components are concentrated by the flow of water and accumulated in the organic layer. A Port Jackson Fig. will accumulate calcium in its leaf litter. Present in the leaf are special structures known as cystoliths. These deposits of calcium carbonate may be observed in a simple unstained cross section of a leaf at only 40 x magnification. See Fig 1, photographs of a cross section of leaf. They are located under the upper epidermis in epidermal cells above the palisade mesophyll. The cystoliths remain in the litter after leaf fall.

At the bottom of the sandstone cliffs water travels through the massive sandstone beds by passing along a combination of bedding planes and block faults. On the way, shell beds are leached and the emerging slow soaks are often highly calcareous, offering a higher calcium level than in the contrasting soil profile developed on the sandstone above.

In the past these examples of gully or cliff face occurrences have been interpreted in terms of the high levels of moisture required by figs. I suggest otherwise. Reflect on the reports in Sydney of many epiphytic occurrences of figs. On old buildings especially favouring lime mortar, many such trees existed but most of these have now been collected by Bonsai growers.

I am working on a method of calcium bio-assay using the cystoliths. It is possible to establish the presence or absence of cystoliths by simple examination of a leaf section. Fig 1, showing photographs from one experiment illustrates the presence of cystoliths in varying quantities. This is done by planting.

Rooted cuttings of *Ficus* taken from the same clone not containing cystoliths in various soil. Leaf examination six months later should give a good measure of the available calcium status of the soil by counting the cystoliths. By further experiment I intend to establish a scale based on cystolith numbers to establish standards and degrees of calcium availability for each site. Selected calciphobic and calcophilic species whose performance in standard soils and to standard applications of calcium is known can be related to experimental cystolith production under the same conditions. This method will be quicker, cheaper, easier and more specific, and more suited to S.G.A.P. members' use than traditional soil analysis methods.

Fortunately, *Ficus rubiginosa* falls into that group of plants already mentioned where excess calcium promotes dwarfing and where iron deficiency chlorosis is not induced. Also as soil calcium is related to the number of cystoliths per given number of cells, not cystolith size, plant and leaf size variation between sites is unlikely to affect an assay which is based on cystolith numbers per given area of leaf, not on total calcium.

I have used the cystolith examination method both on naturally occurring and cultivated trees. With a little practice one can readily recognise deficiency and sufficiency symptoms in the visual appearance of trees, as well as by cystolith counts. Trees that are low in calcium have the appearance of being skeletal with an incomplete open crown, slightly yellowish-green rather than dark green. Many of Sydney's planted specimens that I have examined and which proved very low in cystoliths and hence calcium, had this appearance. Perhaps this has saved them from destruction as more vigorous growth would not be appreciated by councils or building owners.

In the natural populations examined, a good correlation was found between cystoliths, cold exposure and calcium source in the root zone. One anomalous observation was at a site 5 miles N.W. of Bega, N.S.W., where one roadside tree but not adjoining trees showed symptoms of frost damage from winters of 1977/78. The cystolith count was low in this single tree. Other trees in the area were green and had normal counts and no frost damage. At this site the rock is granite overlain on the hilltop by basalt residuals. Road drainage, has taken away the natural down-slope drainage and hence adequate calcium to the tree, probably the basic cause of the frost damage to this anomalous tree.

At Bendethera another anomalous situation in frost damage was observed with one of the three trees previously mentioned but it could not be explained in terms of calcium supply. Maximum and minimum thermometers showed a difference between the lowest minima experienced by trees during the winter of 1978 of 2°C. The difference would be associated with the two unaffected trees growing over the entrance to underground caves and the third not. Warmer air issuing from the caves entrances in winter could have accounted for the temperature difference, and later in this paper I report experimental data which suggests that a 2°C difference in minimum

temperatures could have been the cause of the observed differential in frost susceptibility.

Experimental Method

Fifty plants were raised from cuttings from a single tree of *Ficus rubiginosa* growing at Bendethera, N.S.W. The cuttings were rooted in washed sand and transferred to 15 cm diam. plastic pots containing a known low calcium status sandy loam soil from Black Mountain, Canberra. All pots received a basal dressing of all plant nutrition elements except calcium and iron.

Five replicates of 5 treatments were set up.

Analytical grade Calcium carbonate was applied in three of the 5 treatments as follows:

1. CONTROL (zero added calcium)
2. 6 GRAMS (5 tonnes per hectare appx.)*
3. 12 GRAMS (10 tonnes per hectare appx.)
4. 36 GRAMS (35 tonnes per hectare appx.)
5. LEACHATE FROM TREATMENTS 1-3.

* equivalent surface top-dressing.

Leachate is the excess solution draining from the pots with varying levels of calcium, that we locate on the upper side of a sloping plastic covered bench. The treatment 5 pots were arranged at the lower side of the bench. Thus any pot not at the top of the slope was exposed to leachate from the pots above. The treatment 5 pots therefore received applied calcium only via this leachate and then only after such time as the roots reached the lower portion of the pots. All water was applied to the surface of the pots in quantity sufficient to allow some run through. The controls were raised above the other pots to prevent any root access to leachates from other treatments.

When the plants had been growing for 6 weeks, 25 outdoors (hardened plants in results table) and 25 in an unheated glasshouse, (unhardened), they were subjected to frosting in the liquid nitrogen radiation frost room at the Botany Department, Australian National University, Canberra. (6) During the hardening period for the outdoor plants, they were subjected on several nights to zero or near zero temperatures but never lower. Prior to frosting treatments there were no obvious nutrient disorders apart from height differentials which are shown in Table 1.

The first frosting was carried out on 9.5.78 at a temperature of -2.5°C . The heights of the plants were recorded on this date and again nine days later prior to the second frosting. The plant heights as measured were identical with those taken after another fourteen days had elapsed to allow full frost damage symptoms to develop. (Table 1). The temperature was measured by placing thermocouple wires inside upper leaf surfaces and recorded on a chart recorder. On the 18.5.78 the plants were again frosted at -4°C and all removed to the glasshouse to observe frosting symptoms.

Prior to using the material from Bendethera for experimental purposes a number of preliminary trials were carried out to eliminate the possibility of marked differences in response arising from genetic differences between *Ficus rubiginosa* provenances.

Plants from the Sydney area and Bendethera showed identical responses to the calcium and frosting imposed. At a lower temperature of -6°C all plants showed effects of frosting whether calcium enriched or not. Plants survived this temperature and suffered with some leaf drop and leaf burn. The number of repeated frostings that the plants can survive at this temperature was not determined, but a field recording at Bendethera reached -6°C on at least one occasion during the winter of 1979.

In Canberra, *Ficus rubiginosa* has survived outdoors for three successive winters with adequate calcium but total growth increment is minimal, as summer growth is lost each winter by almost total defoliation, and loss of small diameter stems.

Results

On 1.6.78 the plants were rated for frost damage and growth. Frost damage was assessed by the rating method as described by Paton, (7) their heights were measured.

The results were summarised on Tables 1 and 2.

TABLE 1

Mean Height of Plants (cms) ± S.E. at 9.5.79 and 1.6.78		Mean pH Values of Soil after One Year ± S.E.	
TREATMENT	NOT HARDENED	HARDENED	
CONTROL	9.4 ± 0.7	14.0 ± 1.5	4.5 ± 0.01
LEACHATE	27.0 ± 3.6	28.0 ± 3.9	4.7 ± 0.22
Ca Co ₃ 8g	28.6 ± 2.8	30.6 ± 2.5	7.0 ± 0.07
Ca Co ₃ 12g	28.4 ± 2.0	38.8 ± 1.1	7.7 ± 0.30
Ca Co ₃ 36g	33.2 ± 2.1	32.6 ± 1.1	8.5 ± 0.00

TABLE 2

Frost Damage* after —2.5°C Frosting			After —4°C Frosting	
TREATMENT	NOT HARDENED	HARDENED	NOT HARDENED	HARDENED
CONTROL Means	1.6	0.5	8.8	2.0
LEACHATE "	0	0	1.8	0.4
Ca Co ₃ 8g "	0	0	1.3	0.8
Ca Co ₃ 12g "	0	0	1.7	0.8
Ca Co ₃ 36g "	0	0	2.1	0.9

* Frost damage assessed visually on a 10-unit scale separating unaffected (0), intermediate damage (2-9) and killed plants (10).

Discussions and Conclusions

The growth response to applied calcium was highly significant, Table 1. Applied calcium increased growth from two to three times over that of the controls. In this case the plants in treatments where increased growth resulted from application of calcium, were more frost resistant. Normally increased growth is associated with tenderness and increased frost susceptibility.

This is often the case following responses to fertiliser application particularly nitrogen. Even within control plants, the normal effect of slight frost resistance was apparent in the hardened, compared with unhardened. The plants growing indoors were more tender and hence more frost susceptible compared with the plants that were grown outdoors.

The threshold effect of added lime to frost resistance is shown by the lowest actual level of lime supplied, that is the leachate, it being almost as effective as the heavy levels of applied calcium.

As mentioned previously the calcium effect may be linked with pH but the results shown in Table 2 suggest that neither the growth nor the frost resistance of plants in the leachate treatment were significantly affected by low pH. The increased pH levels in treatments 2 through to 5 (Table 2) could be attributed the observed differences in frost susceptibility and plant height. However, the low pH observed in treatment 2 does not support this assumption. It would seem reasonable then to propose that the action of calcium in the carbonate form is independent of the pH effect.

In assessing the frost damage at —4°C it was noticed the plants developed a mottled pattern of frost damage with patches of several square millimetres of necrotic leaf surface alternating with areas of unaffected leaf. Preliminary microscopic examination showed that there was a relationship between cystolith numbers and affected and unaffected areas, the latter having a higher cystolith count than the necrotic areas.

Perhaps this difference could be associated with the concentration of calcium salts that could affect the freezing point of cell contents. Assuming that the concentration of soluble calcium is higher in those cells having cystoliths, the contents of those cells would freeze at a lower temperature

than otherwise. This could explain the apparent protective action of cystoliths against frost damage.

Conclusions

Calcium is a limiting factor in the growth of the Eastern Australian species *Ficus rubiginosa*. It has a direct effect on its frost resistance and this is offered as an explanation for certain disjunct occurrences of *F. rubiginosa* in frost areas.

The apparent dependence of cystolith numbers in calcium status of this plant suggest that *F. rubiginosa* could be used in a simple bio-assay for evaluating the relative calcium status of different soils. Such a tool if successful has potential for predicting the amount of additional calcium needed for successful growth of other calcium dependent species and would substitute for expensive and often inconclusive conventional soil and plant analyses which are beyond the reach of many.

Outside the realm of Australian plants a further application is suggested in view of the demonstrated frost protection afforded by applied calcium in *Ficus rubiginosa*. Similar responses may be found in economically important species that prove to be tolerant of high levels of calcium.

Great financial losses are often incurred through damage from temperatures well within the range reported in these experiments in such species as tomatoes, citrus and coffee, to cite but a few examples. The screening of such species for tolerance of high calcium levels and possible resulting improved frost tolerance could prove a worthwhile line of investigation.

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STUDY GROUPS

Study groups comprise people maintaining contact by mail through a leader, who share an interest in a special group of plants. They exchange experiences, seed, cuttings, and engage in simple projects aimed at the better understanding of the cultivation requirements of their special interest. If interested, send \$2.00 to one of the following:—

ACACIA	Mrs. Marion Simmons, P.O. Box 1148, Legana, Tas., 7251.
BANKSIA	Mr. Trevor L. Blake, 12 Little John Court, Vermont, V. 3133.
BEAUFORTIA	Mr. Brian Walters, c/- 914 Hume Highway, Bass Hill, N.S.W. 2197.
CALCIUM NUTRITION	Mr. Jim Webb, 22 Araba Place, Aranda, A.C.T., 2614.
CALLISTEMON	Mrs. Doris Phelps, Loxton North, S.A., 5333.
CALYTRIX	Mrs. Joan Doney, 64 Cary Street, Wyoming, N.S.W., 2251.
CYCAD & ZAMIAD	Mr. Leonard P. Butt, 25 Orville Street, Yeronga, Q. 4104.
DRYANDRA	Mr. Tony Cavenagh, 2 Wilkinson Street, Ocean Grove, 3226.
EREMAEA	Leader has resigned. Anyone interested in carrying on the work on this important genus should contact the Editor.
EREMOPHILA	Mr. Geoff Needham, 2 Stuckey Avenue, Underdale, S.A., 5032.
EUCALYPTUS	Mr. L. J. Daniels, Research Str., P.O. Box 201, Biloela, Qld. 4715.
FERN	Mrs. Gerry Parker, 7 Blackbuts Rd., Frenchs Forest, N.S.W. 2086.
GREVILLEA	Mr. Mervyn Hodge, 25 Barford Street, Moorooka, Q. 4105.
HAKEA	Dr. Michael Barratt, Lot 33, Cranebrook Rd., Cranebrook, 2750.
HIBBERTIA	Mr. Bernard Dixon, 82 Gilbertson Road, Kardinia, W.A., 6163.
MELALEUCA	Mr. Ralph Campbell, 58 Lee-Steere Cres., Kombah, A.C.T. 2902.
PROSTANTHERA	Mr. Les Taylor, 4 Prospect Street, Blacktown, N.S.W. 2148.
RUTACEAE	Dr. M. L. Turner, Bush Gems', Old Emerald Rd., Monbulk, V. 3793.
STYLIDIUM	Mr. Richard Davidson, P.O. Box 51, Melton South, V. 3338.

Corrections To Our Past Issue

My most serious mistake was to omit the photographer for that magnificent colour plate on the front cover, *Platycerium superbum*. I wish to record my congratulations and appreciation and those of many readers who have written since, to George Thorpe.

The other major omission was to advise that Len Butt is the leader of a Study Group on Cycads & Zamiads as listed above, and not the Fern Group that is capably led by Gerry Parker.

ORGANIC MATTER AND SOIL — A recommendation by your Editor

This is the title of the latest booklet No. 7, in the series "Discovering Soils" by the CSIRO Division of Soils. It would be, easily, the most fascinating description of what soil is and how it supports plants that I have ever read. A description? More like a story, an epic of adventure as the author takes us into the soil litter with the eyes of a small beetle; then as a smaller creature through the stomach of an animal, out again onto the soil; back down into the soil, dragged in by an ant; studying the structure of the soil from the viewpoint of such a tiny creature; observing the wonder of a plant root growing and forcing its way through the soil; the world of tiny creatures living with and off these new roots; becoming infinitely smaller to examine, almost see, the graphic description being so good, the very molecular structure of the organisms involved; even trifling with the time scale to watch the changes in soil pass before our eyes over the last several thousand years.

And this is but the first twelve pages of this 50-page booklet that uses this build up so that the reader may more readily understand the role of organic matter, the various elements in the soil, nitrogen, phosphorus, etc., as well as the trace elements, and the very structure of soil and its care in the nurturing of plant life.

Readers, you simply must get a copy of this book and acknowledge the fine work of our C.S.I.R.O. and its officers. This No. 7 — Organic Matter and Soils, is available for \$2.00 from the C.S.I.R.O., P.O. Box 89, East Melbourne, 3002.

Previous volumes in this series are advised in our No. 78 issue, page 79. The price has now increased to \$1.25 for Nos. 1, 2, 3 and 5, and \$1.50 for Nos. 4 and 6.

THE SPECIAL OFFER

Editor concerned over delay.

Australian Native Plants by John W. Wrigley & Murray Fagg.

Available as a special offer from The Editor, 860 Henry Lawson Drive, Picnic Point, N.S.W. 2213 for \$25.00 inc. postage — Full price is \$30 plus postage.

There have been many books that have attempted to present the horticultural use of The Australian Flora but this book could reasonably be said to be the most up-to-date and comprehensive book ever. Produced in 448 pages, large pages 28 x 19 cm, and lavishly illustrated by colour photography by that superb photographer, Murray Fagg, with clear line sketches of pests, propagation methods, etc., it is also a production, the publishers, Collins, can be very proud of.

The magic ingredient however is the writing of John Wrigley, the Curator National Botanic Gardens, Canberra. John has always been a keen home gardener of Australia's wildflowers and was a key figure in the creation of the Kuring-gai Wildflower Garden. He is fully aware of what the home gardener needs to know and how to present it in easily understood terms. Supplement this basic understanding with professional scientific qualifications, a keen intellect and the ability to observe and record vital information, together with the experience as Curator of the National Botanic Gardens for many years, and you have a book of immense value.

Australian National Parks & Wildlife, Vol. 2, No. 3-4

Why not join the National Parks & Wildlife Service of N.S.W. and receive their two publications a year at an annual subscription of \$5.00. The latest large 160-page book above refers to all the national parks of Australia, with magnificent colour plates. The next 121-page book explores the life styles and technology of the Aboriginal people before settlement in N.S.W. The first, in 1980, will be on endangered animals in N.S.W.

Australian Conservation Foundation

You may join the vital Australian Conservation Foundation for \$24.00 per annum, or just subscribe to its colour periodical "Habitat" for \$5.00 per annum. The August issue has 30 pages with some magnificent colour photography. Why not contribute and learn more of the critical situation of today, conservation and environment.

The Australian Orchid Foundation

The foundation extends an open invitation for applications for support or grants by any person or group who has a desire to do specialised work on any subject that relates to orchids. The Foundation is a voluntary and non-profit organisation dedicated "to collect, preserve, protect, promote, propagate, nurture and cultivate orchids . . ." Enquiries and donations, bequests, etc., may be forwarded to The Australian Orchid Foundation, 107 Roberts Street, Essendon, Vic., 3040.

The Kangaroo Paws

by STEPHEN D. HOPPER, Western Australian Wildlife Research Centre
P.O. Box 51, Wanneroo, W.A. 6065

Introduction

The 12 species of kangaroo paws rank among the most spectacular of the many wildflowers endemic in the south-west of Western Australia. Their richly coloured flowers have long attracted interest among native plant growers. Birds are the natural pollinators of the kangaroo paws and, consequently, a garden containing some of these plants is bound to be alive with honeyeaters in the flowering season.



Anigozanthos gabrielae

Photography by E. Humphreys

Anigozanthos gabrielae. This diminutive species, previously known as *A. bicolor* var. *minor*, is restricted to winter-wet swamps and creeks immediately to the north and south of the Stirling Range in W.A. It appears in large numbers the first spring after a bushfire but fails to persist in subsequent years. The flowering stems are usually 5-15 cm tall and splay outwards from the rhizome. The flowers are 2-4 cm long, in contrast to those of *A. bicolor* which are 4-6 cm long. As with the other red and green kangaroo paws, *A. gabrielae* has rare colour variants including an all red form and a form with yellow-orange ovaries.

I became interested in the group on learning that some kangaroo paw species hybridise in nature. Because the hybridising species often show striking differences in floral colouration and floral structure, their natural hybrids are easy to recognise and have provided excellent material for ecological and evolutionary studies (Hopper 1977a, 1977b, 1978a, 1978b, 1978c; Hopper and Burbidge 1978).

In the course of my initial work on the kangaroo paws it came as something of a surprise to find that, despite their horticultural popularity, there was very little published information available on the biology of the group. Useful summaries of existing data were provided by Grieve and Marchant (1963) and Beard (1963), but it was apparent that much more research was required for a sound understanding of the ecology, evolution and cultivation of the species. Moreover, a taxonomic revision of *Anigozanthos* published by Geerinck (1970) contained several contentious changes with which Western Australian taxonomists disagreed. It was clear that further work was necessary to produce a satisfactory resolution of these points of disagreement on the classification of the kangaroo paws.

In the present article I aim to summarise results of recent studies which have clarified taxonomic relationships in the group. It is hoped that this contribution will serve to standardise the names used in future publications on the kangaroo paws.

Correct Spelling of Names

Some confusion still persists as to the correct spelling of the generic name *Anigozanthos*. Eichler's (1971) thorough consideration of the subject established that the fourth syllable of the name commences with "z" rather than "s", and that ". . . os" rather than ". . . us" is the correct ending. Thus, *Anigozanthos* is correct; *Anigosanthos*, *Anigosanthus*, *Anigozanthus* and other variants are incorrect.

Another source of confusion and dispute concerns the correct endings for the spelling of *A. flavidus*, *A. pulcherrimus* and *A. rufus*. The names of these species traditionally have ended in ". . . a" rather than in ". . . us". However, both Geerinck (1970) and George (1974a) have pointed out that the original spellings were at variance with conventions proposed in the International Code of Botanical Nomenclature. Most taxonomists now agree that ". . . us" is the correct ending for the names of *A. flavidus*, *A. pulcherrimus* and *A. rufus*.

Status of The Black Kangaroo Paw (*Macropidia fuliginosa*)

In the first comprehensive treatment of the kangaroo paws, Bentham (1873) placed the black kangaroo paw in a separate genus (*Macropidia*) from all the other species. Subsequently, this view has been accepted by most Australian taxonomists. However, Mueller (1873) and Geerinck (1970) chose to disagree and argued that *M. fuliginosa* should be incorporated within *Anigozanthos*. Recently, an attempt to resolve this conflict was undertaken through comparative studies of floral structure, seed morphology, ecology, reproductive biology and interspecific crossing relationships (Hopper and Campbell, 1977; Hopper, 1978b). The weight of evidence arising from these studies indicates that the recognition of *Macropidia* as a genus distinct from *Anigozanthos* is in closest agreement with genetic and morphological relationships. Attempts to obtain hybrids between *M. fuliginosa* and species of *Anigozanthos* from controlled pollinations were uniformly unsuccessful, whereas hybrids were produced from all interspecific combinations of *Anigozanthos* investigated.

Status of *Anigozanthos viridis* and *A. bicolor*

Bentham's (1873) widely accepted recognition of these two taxa as distinct species was challenged by Geerinck (1970), who proposed that they were more appropriately regarded as varieties of the same species. Quantitative morphological studies (Hopper and Campbell, 1977) indicated

that the two taxa were clearly distinct in leaf shape, and largely (but not entirely) distinguishable in floral shape and size. More recently Hopper (1978b) has established that partially sterile hybrids are produced when *A. viridis* and *A. bicolor* are cross-pollinated. The evidence now available suggests that these two taxa show sufficient morphological and genetic differentiation to be regarded as separate species.

Status of *Anigozanthos bicolor* and *A. gabrielae*

Bentham (1873) named two varieties of *A. bicolor*, one of which (var. *major*) was widespread in woodland areas marginal to the main jarrah forest of the south-west, and the other (var. *minor*), which was confined to the Stirling Range area. Subsequently, Domin (1912) elevated var. *minor* to specific rank, naming it *A. gabrielae*. This proposal did not gain widespread acceptance among Australian taxonomists and was largely forgotten until Geerinck (1970) agreed with Domin in regarding *A. gabrielae* as specifically distinct from *A. bicolor*. Morphometric studies have confirmed that the two taxa are distinct in floral, leaf and seed structure (Hopper and Campbell, 1977). Crossing experiments have established that while some reduction in seed set occurs on hybridisation, the resultant F_1 hybrids are fully fertile (Hopper 1978b). These data suggest that *A. gabrielae* and *A. bicolor* are very closely related and are probably best regarded as "semispecies" in an evolutionary sense (Grant, 1971). While the choice of taxonomic rank is to some extent arbitrary in such a situation, the morphological differences between *A. gabrielae* and *A. bicolor* are certainly comparable to those used to distinguish other closely related species in *Anigozanthos* (e.g. *A. rufus* and *A. pulcherrimus*). Accordingly, I consider it appropriate to regard these taxa as separate species.

New Species of *Anigozanthos*

Two new kangaroo paws have been described in recent years (George, 1974b; Hopper, 1978d). Both are localised in distribution, and both may have escaped detection until the current decade because they appear to occur in large populations only the first growing season after a bushfire or following other forms of habitat disturbance such as chaining or bulldozing. Improved access to the habitats of the new species in the 1970's also probably contributed to their discovery.

Anigozanthos onycis A. S. George (branched catspaw)

This species is a perennial herb producing ephemeral dark green leaves 5-15 cm long and 2-15 mm wide. Scapes are few per plant and 15-30 cm high. Racemes number 2-8 and are widely branched as in *A. pulcherrimus*. Up to nine flowers per raceme are produced, the indumentum usually being dull red or yellow suffused with red. Perianths are 3-5 cm long, with spreading horizontal lobes giving the flower a claw-like appearance as in *A. preissii*. Stamens are inserted at two levels in the perianth, the central four having filaments 3-4 mm long and the outer two with filaments 6-8 mm long. Anthers are 3-4 mm long and tipped with small appendages as in *A. flavidus*.

A. onycis occurs on hillslopes and sandplains in mallee heathland in the Stirling Range-Bremer Bay area. It is one of the rarest kangaroo paws, usually occurring in small roadside populations on verges which have been bulldozed or burnt. It flowers from late August to early November, reaching a peak in September-October.

Limited experimental data suggest that heat pretreatments (two hours in a waterbath at 55-60°C) considerably boost germination (Hopper 1978b). However, the species appears to be short-lived in cultivation, usually succumbing to fungal infection within two years of germination under a daily watering regime.

A. onycis has a number of morphological features suggesting affinities with members of the branched species group (notably *A. preissii*) and the single-stemmed species group (in particular *A. humilis*), and thus provides a link between the two major subgeneric divisions within *Anigozanthos* (Hopper and Campbell, 1977).



Photography by S. D. Hopper

***Anigozanthos onycis* (above)**

One of the two new kangaroo paws named recently, this plant grows in disturbed habitats in the Stirling Range—Bremer Bay area of W.A. Flowering stems are 15-30 cm high and the flowers are up to 5 cm long. The species name, derived from the Greek *onyx* (a claw, talon), refers to the claw-like appearance of the open flowers. See previous page for further details.

***Anigozanthos kalbarriensis* S. D. Hopper (Kalbarri catspaw).**

A. kalbarriensis is a perennial herb with slightly glaucescent ephemeral leaves up to 12 cm long, 3-10 mm wide, and the lower ones curved as in *A. humilis*. Several unbranched scapes 10-20 cm high are produced, each bearing a single terminal raceme of 3-20 flowers. Perianths are 2.5-4.5 cm long with lobes reflexed 180° backwards as in *A. manglesii*. The indumentum is consistently red on the scape and ovaries, but may be yellow suffused with red, pale green or golden yellow on perianths. Stamens are inserted at three levels as in *A. humilis*, the outer pair characteristically being low in the perianth and more distant from the second pair than the second and central pairs are from each other. Filaments and anthers are approximately equal in length, ranging from 1.5 to 2.5 mm.

This species is a localised endemic of the low heathlands immediately north and south of the lower reaches of the Murchison River. It appears to favour early succession post-fire communities occupying winter-wet depressions in undulating sandplain. It flowers from August to October.



Anigozanthos kalbarriensis

Photography by J. Glass

Anigozanthos kalbarriensis. This species is restricted to the heathlands of the lower Murchison River in Kalbarri National Park. It is readily distinguished from the common catspaw (*A. humilis*) in having perianth lobes that curl up and back along the floral tube. The red colouration of the plant illustrated is the colour most commonly seen. Occasional golden yellow, and yellow-suffused-with-red forms are also known. Although the kangaroo paws are among the better known plants of south-western Australia, *A. kalbarriensis* escaped detection and was not recognised and named as a distinct species until 1978. Its flowers are 3-4 cm long, and flowering stems are 5-20 cm high.

Attempts to germinate seeds, with and without heat pretreatment, have met with little success (Hopper, 1978b; R. Dixon, pers. comm.). In addition, the few plants raised in cultivation were prone to fungal attack and died within two years of germination.

A. kalbarriensis is related to *A. humilis*, the common catspaw, but also shares certain characteristics with *A. manglesii* and its allies. It has been suggested that *A. kalbarriensis* may be a stabilised backcross derivative of natural hybrids of *A. humilis* and *A. manglesii* (Hopper, 1978b), but further work is required to substantiate this hypothesis.

Undescribed Subspecies of *Anigozanthos*

Recent morphometric studies of intraspecific geographical variation (Hopper, 1978b, unpublished data) indicate that four of the single-stemmed kangaroo paws have geographical races that are sufficiently distinct from nominate races to warrant recognition as subspecies. These as yet unnamed taxa include the yellow race of *A. humilis* from Mogumber, a short-stemmed race of *A. bicolor* with markedly constricted perianths which ranges from Williams southwards, the northern (Eneabba-Shark Bay) race of *A. manglesii* with red-orange ovaries, large flowers and occasionally branched scapes, and a short-stemmed race of *A. viridis* with metallic green flowers that is confined to the Cataby Creek-Nambung area north of Perth. Another taxon possibly deserving subspecific rank is a race of *A. pulcherrimus* with hirsute leaves which is presently known only from the Mogumber area.

Colour Variants of Kangaroo Paws

Rare flower colour variants are now known for several species. As yet, none of these variants has been given formal taxonomic status, and only a few have been registered as cultivars. Red and orange hues appear in *A. flavidus*, particularly in the Margaret River district. Flowers of *A. humilis* are sometimes red, pink, pure yellow and very rarely almost white. Populations of the normally red-and-green species (*A. manglesii*, *A. bicolor* and *A. gabrielae*) occasionally contain plants with yellow or red perianths and orange ovaries. *A. viridis* appears with colours ranging from dark metallic green through to lemon yellow, and very rarely a purple variant may be found. *A. kalbarriensis* has a range of colour variants in any one population (as described above). *A. pulcherrimus* occasionally appears orange rather than the normal golden yellow colour. *A. rufus* has been recorded on rare occasions in a yellow form which has led to erroneous claims for south coastal occurrences of *A. pulcherrimus*.

With the exception of the red and orange forms of *A. flavidus*, none of these colour variants have been used extensively in the nursery trade. It is of interest to note that Mr. R. Dixon of King's Park and Botanic Garden has established that the orange colour variants of *A. manglesii* breed true when hand-pollinated among themselves. I have obtained similar results for variants of *A. humilis*, *A. viridis* and *A. bicolor*. Thus, there would appear to be a rich field for future work by plant breeders in developing commercial quantities of the many attractive colour forms now known.

Key to the Species of Kangaroo Paws

1. Flowers black and green; anthers borne on filaments 25-35 mm long; ovules one per locule *Macropidia fuliginosa*
1. Flowers red and green, green, yellow, yellow-suffused-with-red, orange or red; anthers borne on filaments less than 15 mm long; ovules two or more per locule *Anigozanthos* spp.
2. Inflorescences solitary on a vertical stem
3. Stamens inserted at three levels in the perianth
4. Perianth lobes horizontal or reflexed vertically no more than 90°; flowers entirely yellow or yellow-suffused-with-red; wide-spread in south-western Australia *A. humilis*

4. Perianth lobes reflexed backwards 180°; flowers two-coloured with red ovaries and green, yellow or red perianths; lower Murchison River area only *A. kalbarriensis*
3. Stamens inserted at one or two levels in the perianth
 5. Flowers entirely green or yellow-green *A. viridis*
 5. Flowers two-coloured with red ovaries and green perianths
 6. Perianths 6-10 cm long and not constricted markedly near the stamens; anthers 5-10 mm long, much longer than the filaments *A. manglesii*
 6. Perianths less than 6 cm long and noticeably constricted in width near the stamens; anthers less than 5 mm long, equal to or shorter than the filaments
 7. Inflorescences 20-70 cm high; perianths 35-60 mm long *A. bicolor*
 7. Inflorescences 5-20 cm high; perianths 25-35 mm long *A. gabriellae*
2. Inflorescences numerous on a dichotomously branched stem, or in close pairs on a shortly divided vertical stem
 8. Inflorescences in close pairs on a shortly divided vertical stem; perianths 50-60 mm long *A. preissii*
 8. Inflorescences numerous on a dichotomously branched stem; perianths 30-50 mm long
 9. Back of anthers orange; inflorescence usually 1.5-3.5 m tall; flowers lemon green, occasionally suffused with red *A. flavidus*
 9. Back of anthers green; inflorescence less than 1.5 m tall; flowers golden yellow, crimson-red or orange
 10. Perianth lobes horizontal; inflorescences 10-30 cm high; flowers orange-red *A. onycis*
 10. Perianth lobes reflexed backwards 180°; inflorescences 50-150 cm high; flowers golden yellow or crimson-red
 11. Flowers golden-yellow *A. pulcherrimus*
 11. Flowers crimson-red *A. rufus*

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Anigozanthos bicolor

Often referred to as the small red and green kangaroo paw it is a smaller edition of *A. manglesii* growing to 20-70 cm tall with narrower leaves. The perianth (flower) is also smaller, less than 6 cm long and noticeably constricted in width near the stamens. However the flowers are larger than *A. gabrielae*. The plant illustrated belongs to the southern race of *A. bicolor*, characterised by short flowering stems (20-50 cm), a purple tinge to the red ovary, and very constricted perianth. The northern race, ranging from Mt. Cooke to Mogumber, has erect stems up to 70 cm tall, rich red ovaries, and only slightly constricted perianths.

***Anigozanthos humilis* x *A. manglesii* (opposite top)**

An inflorescence of this hybrid is shown in between an inflorescence of *A. humilis* on the left and an inflorescence of *A. manglesii* on the right. The colour of the hybrid illustrated is that most commonly seen. Occasional plants that are all red or red stemmed with golden yellow perianths have been produced. A spectacular population of *A. humilis*, *A. manglesii* and their natural hybrids occurs in the shire cemetery at Gingin, 80 km N. of Perth, in W.A. This population is regularly visited by wildflower tourist buses, and has been studied in some detail by Dr. Stephen Hopper and his colleagues (see references listed on page 235).

Photography by Eric Crane

***Anigozanthos humilis* — The Cats Paw**

A magnificent plant. The smallest of the paws but one of the best. It is the most widespread species of *Anigozanthos*, ranging from the Kalbarri area in the north some 670 km south to Ruabon on the west coast and 900 km south-east to Hopetoun on the south coast. It skirts around the main jarrah forest belt, favouring woodlands and heathlands on deep sand. A number of forms are recognised over its considerable geographical range, including a pure yellow race with erect stems up to 60 cm tall from Mogumber. Northern populations are diminutive, with 5-15 cm flowering stems and very small flowers.



Anigozanthos humilis

A. humilis x *A. manglesii*

A. manglesii



Anigozanthos humilis

Ant Plant

by Bob Smythe, Townsville, Qld.

Ant plants are malformed bulbous epiphytes found in North Queensland at least as far south as Townsville where it is quite common. Two other epiphytes often found associated with the Ant Plant are *Dendrobium canaliculatum* (Tea Tree Orchid) and *Dischidia nummularia* (the so-called Button Orchid which is not an orchid).

The three epiphytes mentioned prefer as their host pure stands of *Melaleuca viridiflora*, with the Tea Tree Orchid occurring only very rarely in areas of mixed forest. These melaleuca stands occur in very infertile alkaline soils along the coast. The soil is usually saturated with water for three months of the year and colonised with very little undershrubs. The plants are patchy and have a marsh blue appearance. The rest of the year is very dry and probably during this period the Ant Plant draws its water from its enlarged stem and from deeper layers of the paper bark of *M. viridiflora*. The large swollen stems of the Ant Plant are honeycombed with tunnels which harbour myriads of ants (hence the common name). Many an over-zealous orchid collector has been set back a pace by mistakenly collecting this plant for an orchid.

The flowers are uninteresting, being simply a white tubular translucent appendage 1 to 2 cm long bubbling out of the diminutive but gnarled trunk.

Refer to the colour plates in "A Horticultural Guide to Australian Plants" of the Ant Plant species *Myrmecodia antoinii* and *Hydnophytum formicarum*.

It is said that there is no symbiosis between ant and plant and I cannot disprove this, but the apparent gregarious nature of these plants, often forming together into one large mass, makes me think that at least in return for shelter the ants might involve themselves in seed dissemination (or lack thereof) and/or germination.

Ant Plants have been successfully grown in bush houses without ants and make a rather attractive pot plant. They must be grown in very open, well-drained media. Pumice stone would be suitable but a local stone of volcanic origin called Quincan Gravel (Scoria) is most successful.

A Horticultural Guide To Australian Plants

See page 243 for prices

This society publication has been described in previous issues. This is to announce the availability of sets 5 and 6 of these magnificent colour plates of plants with accompanying descriptions available for \$3 per set including postage. Of topical interest are the colour plates of the Ant Plants mentioned above, *Myrmecodia antoinii* and *Hydnophytum formicarum*. Our previous issue featured the Stag and Elk Horns and readers are referred to the colour plates of *Platyserium veitchii* and *P. hillii* in the horticultural guide series.

Vegetation Maps of Western Australia

\$6.00 each plus postage

Available from Vegmap Publications, 6 Fraser Road, Applecross, W.A. 6153.

These comprise 20 maps, scale 1: 250,000, of the wildflower areas of Western Australia stretching from Israelite Bay to Shark Bay in the North. Please refer to the full page report on this series, page 82 of issue No. 78. If you are going to W.A. you must have these maps. The final 4 in the series are now available from the publisher.

Perfumed and Aromatic Australian Plants

Price \$2.00, plus 60c postage.

This 172-page little book has been prepared by the members of the Western Suburbs Branch of the Society in Brisbane, and a lot of work has gone into it. They have devoted a page to mention each of some 150 species of wildflowers that they have noted are perfumed or produces a noticeable smell. Everyone knows the joy of savouring the perfume of the Brown *Boronia megastigma*. There are many more plants, possibly not so noticeable, that contribute to the bushland fragrance. This book represents a first report on their efforts. They also have this information in a loose-leaf form and a suitable binder for \$4.50, plus 80c postage.

The Society — Where are we going?, What have we done?

With this periodical in its 21st year and the society in its 23rd year, perhaps we should pause and reflect what has been achieved and where we should direct our energies. It has been policy to restrict comment in this publication to matters directly related to the flora and leave Society matters for our other publications circulated to members only. Just for this, our 21st year, we will include comment on Society matters of general interest.

The Australian Flora — Its preservation!

This is our objective. In its broadest sense, this does not only mean its conservation in parks and in the wild. There are many other conservation societies whose total aims are directed in this area and a decision was taken very early, in fact the very reason for forming the Society, that this Society will support these conservation bodies to the maximum extent possible, but that we should concentrate on the largely neglected area of its cultivation.

There seems little doubt that, as man increases his pressures on the environment and the natural features of this restricted world of ours, interference with the natural order of all life forms will eliminate many irreplaceable treasures which includes much of Australia's unique flora. We will have to find a way to maintain life in this new environment and just fencing off areas and calling them reserves without suitable care and management is only a start.

Conversely, nobody really believes that we will preserve our flora by cultivation in home gardens or even specially established public gardens. But! There is hope that lessons being learned in the propagation and cultivation of our wildflowers by home gardeners will make a significant contribution to the ultimate objective — the preservation of the Australian Flora.

Quite reasonably there has been concern by members that the Society has not devoted proper attention to the conservation of the flora in the wild. The officers of the Society are honorary, certainly dedicated, but overworked and in need of support. Is it little wonder that they have had to direct their energies to the Society's primary objective. Their concern remains.

What is to be done? If the Society's executive body examined the very numerous conservation issues that continue to arise, they would have no time for other matters relating to cultivation. Conversely the situation in many areas has become critical and some action becomes an obligation. The Society in each State is very concerned about all matters including conservation and is taking measures that suit their circumstances. Meanwhile members especially concerned should enquire how they can help as well as joining and giving support to the various action groups especially created for conservation.

At the recent Federal Conference, Chris. Cobbold was appointed Federal Conservation Liaison Officer.

Vale—Arthur James Swaby

It is with abiding respect that we record the passing of the founder of the Society for Growing Australian Plants. He died at the ripe old age of 92 years on the 20th October, 1979. The Society was well represented at the funeral by Victorian members.

Arthur Swaby formed the Society using *Your Garden* as the venue, in 1956. A staunch member of the Field Naturalist Club of Victoria he saw the need for a society of people especially concerned with the cultivation of our Australian Flora and its horticultural development. The response to his initial urging was enthusiastic leading to the Society as it is today of more than 10,000 members from all areas of this unique continent.

May he rest in peace, a life well spent, the Society being a continuing testimonial to a fine Australian.

Australian Native Plants by A. M. Blombery Price \$15.95, plus 55c postage.

When I received this new edition of the book by Alec Blombery I dug out my copy of its first printing in 1955. Knowledge of Australia's wildflowers has come a long way since those days. The book has grown from 100 pages to 480 pages. Then Alec had the knack of presenting his wide knowledge in such clear terms he inspired many thousands of people to try and propagate and grow a few wildflowers. This new, completely revised edition illustrates how much we have learnt about wildflowers and their cultivation in the last 25 years, especially Alec Blombery. But! Alec, as always, is so generous with the knowledge that he gains from careful observation, study and shrewd deduction. A lifetime of experience by one of Australia's leading wildflower horticulturalists is contained in this book, written in a clear, simple, but accurate style that Alec himself calls the commonsense approach.

—Editor.



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