

and temperature and their effect on rooting is obviously complex and will require further investigation in the future.

Acknowledgement. The excellent technical assistance of J. Groves is gratefully acknowledged.

LITERATURE CITED

1. Bunker, E.J. 1981. Growing certain Australian native shrubs and trees from softwood cuttings. *Proc. Inter. Plant Prop. Soc.* 31:130-133.
2. Burke, D. 1983. Growing Grevilleas in Australia and New Zealand. Kangaroo Press, Sydney.
3. Buscher, F.K. and D. Van Doren. 1973. Determination of air-filled pore space for container-grown nursery stock. *Proc. Inter. Plant Prop. Soc.* 23:232-234.
4. Dupee, S.A. and J. Clemens. 1981. Propagation of ornamental Grevillea. *Proc. Inter. Plant Prop. Soc.* 31:198-208.
5. Ellyard, R.K. 1976. Effect of supplementary light and auxin applications on rooting leafy cuttings of certain Australian species. *Proc. Inter. Plant Prop. Soc.* 26:395-401.
6. Ellyard, R.K. 1981. Rooting hormones. Their effect on the rooting of some Australian species. *Aust. Plants.* 11:161-165.
7. Ellyard, R.K. 1984. Propagation of *Eriostemon australasius* Pers. from cuttings. *The Plant Propagator* 30(1):10-13.
8. Ellyard, R.K. unpublished data.
9. Grange, R.I. and K. Loach. 1983. The water economy of unrooted leafy cuttings. *Jour. Hort. Sci.* 58:9-17.
10. Hellriegel, F.C. 1982. The nature of callus and its importance to the plant propagator. *Proc. Inter. Plant Prop. Soc.* 32:65-74.
11. Howard, B.W. and N. Nahlawi. 1969. Factors affecting the rooting of plum hardwood cuttings. *Jour. Hort. Sci.* 44:303-310.
12. Lamont, G.P. 1981. Propagation of *Boronia serrulata* Sm. (Native Rose) from cuttings. *Proc. Inter. Plant Prop. Soc.* 31:184-190.
13. Ooishi, A., H. Machida, T. Hosoi and H. Komatsu. 1978. Root formation and respiration of cuttings under different temperatures. *Jour. Japan Soc. Hort. Sci.* 47(2):243-247.

HORTICULTURAL DEVELOPMENT OF AUSTRALIAN PLANTS

JOHN W. WRIGLEY

P.O. Box 1639

Coffs Harbour 2450, Australia

Abstract. The potential of Australian native plants is examined over a broad spectrum of horticultural applications. The history of the development of this potential is traced and the future direction to which research should be aimed is proposed. The flora is examined for its potential in such categories as garden subjects, cut flowers, dried flowers, amenity plants for arid areas, forage plants for arid areas, indoor plants, and economic plants.

INTRODUCTION

. The Australian angiosperm flora has been variously estimated at upwards of 20,000 species. This rich resource of plant material is distributed over a vast continuum of climate and soil type resulting in a flora that has potentially valuable components for almost every horticultural purpose.

From the alpine areas of the south-east of the continent to the humid tropical rainforests of the north; from the floral wonderland of the southwestern sandplains, with their Mediterranean climate, to the immense arid centre, we have a variety of plants of which even the average Australian is unaware.

Despite the early effort of botanical collectors in the early and mid-nineteenth century when many Australian plants were being brought into cultivation in Great Britain, it is only in the last 25 years that increasing local interest has been shown in the cultivation of native plants. Several reasons may be suggested for this revived interest in the flora.

Firstly, a sense of nationalism and an increasing awareness of the environment began to develop in the '50's and '60's and the trend is still with us. People became conscious of the shrubs and trees around them and realised that they had a place in the man-made environment as well as in nature.

Coincident with this trend, the Society for Growing Australian Plants was formed in the late '50's and very soon became the largest horticultural society in the country. Native gardens became popular and a near-fanaticism developed among some members, claiming that "natives" were right and "exotics" were wrong. In 1959 the Society launched a full-colour quarterly journal "Australian Plants". It has continued to be produced and has become an important horticultural periodical with circulation to many overseas countries.

Finally, the establishment of the National Botanic Gardens in Canberra which was officially opened in 1970, and King's Park & Botanic Garden, Perth, (1965) has contributed much to the horticultural knowledge and the popularisation of Australia's floral heritage.

POTENTIAL

Of the 20,000+ species of plants in the flora, many have little or no value for ornamental purposes. Some of these "ugly ducklings" however, may have use as,

- i) forage plants in arid areas, e.g. several species of salt-bush, family Chenopodiaceae.
- ii) sources of pharmaceutical compounds, e.g. *Solanum*

aviculare and its tetraploid form, which is often called *S. laciniatum*, as a source of solasodine for cortisone and other steroid drugs.

iii) economic crops, e.g. *Macadamia integrifolia* and *M. tetraphylla* for edible nut production.

It is now proposed to briefly examine some elements of the flora to indicate their potential in various categories.

Ornamental plants

(a) *Garden subjects.* Some years ago the average retail nursery stocked half a dozen or so species of native plants and buyers had to search for the few specialist nurserymen who stocked an extensive range. Today the story is very different as most general nurserymen have a large section set aside for native plants. The range is still limited in terms of the potential that exists but a definite trend is in evidence.

There is a need, however, for nurserymen to improve their knowledge of native plants and to understand how a certain species performs in their area. Much misinformation is being passed on and many species are being stocked which are unsuitable for the local area. As mentioned earlier, there is a range of species available for each climate and soil type but it is important for the correct selection to be made and for the right advice to be given to potential buyers.

There are probably between 7,000 and 10,000 species of ornamental native plants currently being cultivated in Australia. Many of these are still in very short supply but the figure indicates the potential.

(b) *Cut-flowers.* The cut-flower trade is big business in Europe and the United States. Old established blooms, such as roses, carnations, and chrysanthemums are favourites and are among the top sellers. There is a demand, however, for different species and for long-lasting flowers and the Australian flora has much to offer in these categories.

Some years ago the Israelis were quick to see the potential of many Western Australian native plants and farming of a number of species for the European market became well established. Plants such as Geraldton wax flower (*Chamelaucium uncinatum*), kangaroo paws (*Anigozanthos* spp.) and *Banksia* spp. found their way into large selling enterprises such as Aalsmeer in Holland. The Americans, too, were experimenting with banksias and other proteaceous plants in Hawaii.

In Australia, however, several Western Australian companies have employed licensed pickers and the majority of cut-flowers which have appeared on local and overseas markets have been from this source. In 1980-81 the export value

of cut-flowers (not all Australian natives) from Australia was approximately \$1.2 million. The wholesale value of Western Australian cut-flowers (local and export markets) for the same period was \$1.5 million.

Australia has a major marketing advantage with respect to exporting of cut-flowers because of the different flowering seasons to the northern hemisphere and once these species become well-known the market is bound to increase.

Recently, the Western Australian Government has announced incentives for farming wildflowers in that State and also the funding of research into their cultivation. Although these measures should have been taken some years ago, it is encouraging that they have eventually been initiated. Farming of a number of Western Australian proteaceous plants has been progressing well in South Australia for several years.

Although emphasis has been placed on Western Australian wildflowers, such species as the New South Wales waratah (*Telopea speciosissima*), Christmas bells (*Blandfordia* spp.), flannel flower (*Actinotus helianthi*) and N.S.W. Christmas bush (*Ceratopetalum gummiferum*) have equal potential as cut-flowers.

(c) *Dried flowers, fruits and foliage.* Many Australian native plants perform well as dried plant material. Most of these belong to the families Asteraceae (Compositae) and Proteaceae but several Myrtaceae genera are also gaining favour.

Everlasting, or paper daisies, from the genera *Helipterum* and *Helichrysum* have been well-known for this purpose for many years and, in fact, many colour forms of *Helichrysum bracteatum* were developed in Europe and seed of several species of paper daisies has been available from European seed companies for some years. *Ixodia achilleoides*, another composite, is marketed in large quantities after drying.

Of the Myrtaceae genera, *Agonis*, *Thryptomene*, and *Scholtzia* have considerable potential in the field.

A large export market and a substantial local market exists for dried material and companies have been established in Western Australia and South Australia to cater for it.

Plants for Arid Areas

(a) *Amenity plants.* Middle Eastern countries in recent years have used their petrodollars to improve their arid environment by the addition of plants. It has been found that many Australian plants adapt well to these climates and delegations from Australia have been successful in opening markets for the export of Australian species for use in amenity horticulture.

(b) *Forage plants*. In addition to ornamental plants, Australia's great arid heart has evolved some excellent forage plants. Research in this field is still young but Central Africa, the Middle East, and India, where an arid climate is often associated with saline soils, are all potential users of Australian plants as forage.

(c) *Firewood*. Firewood is a diminishing resource in many tropical countries, where thoughtless clearing without replanting has occurred for many years. Fast growing eucalypts are being used for this purpose in India and South America.

Indoor Plants

(a) *Foliage Plants*. Most of the plants that we know so well as reliable indoor foliage plants have their origin in the world's rainforests. Australia's own rainforest flora has been barely tapped for this purpose. With exception of species such as *Schefflera actinophylla* (umbrella tree) and *Grevillea robusta* (silky oak), few have been used to grace our living rooms and office buildings. European countries are keen to expand their range of plants and have demonstrated a keen interest in plants from Australia.

(b) *Basket Plants*. The basket plant market is expanding in Europe and the United States and the quest for new species is continuing. The Australian flora has rarely been used for this purpose and yet many of our low-growing, spreading plants are eminently suitable.

Economic Plants

(a) *Pharmaceuticals*. Mention was made earlier of two *Solanum* spp. that have been used commercially for pharmaceutical production. Many other species have been used for the production of alkaloids used for various purposes, such as the control of uterine spasms, anti-cancer activity, anti-bacterial activity, ophthalmology, etc.

Duboisia myoporoides and *D. leichhardtii* have been collected from the field for many years in N.S.W. and Queensland for the extraction of scopolomine and hyoscyamine but now, a hybrid has been produced which gives better results. This cultivar is being grown commercially in Queensland.

Medical research work is continuing to uncover more pharmaceutical uses for Australian plants and it is important that such screening has as wide a coverage as possible. The conservation of our flora is thus vital so that the full potential of native plants for this purpose can be realised.

(b) *Timber, honey, fruits, etc.* The timber industry has been well-established in Australia for many years but unfortunately the control of timber cutting has left much to be desired. The

sad history of red cedar (*Toona australis*) logging is now legend and the total banning of rainforest logging in N.S.W. is the result of ruthless cutting without thought of re-establishment for future use.

Attempts are currently being made on the mid-north coast of N.S.W. to establish red cedar plantations. This should be extended to other timbers such as rosewood (*Dysoxylum fraserianum*), Queensland maple (*Flindersia brayleyana*, *F. pimenteliana*), etc.

The honey flora of Australia is well documented and this country is now fourth in the world in terms of honey production, with an annual yield of approximately 20 million kilograms.

Specialty products, such as leatherwood honey from the Tasmanian rainforest tree, *Eucryphia lucida*, have a unique flavour and are favoured by connoisseurs.

Australia is not generously supplied with plants that have edible fruits and nuts and that are considered palatable to the European taste. There are some, however, and perhaps with a little research some could be developed to commercial status. The macadamia nut has already been mentioned and many hectares of this tree have been planted in northern N.S.W. and southern Queensland.

Eremocitrus glauca (desert lime) and *Santalum acuminatum* (quondong) are two desert plants which have potential for dry area production, the latter having already attracted some research attention. The rainforests also yield plants that may have commercial potential with appropriate selection and breeding. Such species include *Pleiogynium timorense* (Burdekin plum), *Tetrastigma nitens* (a native grape), *Microcitrus inodora* (a native lime), and several *Antidesma* spp.

HISTORY OF HORTICULTURAL DEVELOPMENT

As Australians we have been slow to embark on research programmes aimed at the horticultural development of our flora and to date more work has been done outside the country than within. Brief mention has already been made of some of this work and it is proposed to concentrate, here, on local developmental work.

Selection and breeding. Selection, of course, is the prerequisite of any development programme and from early plantings and descriptions of native plants sent back to Great Britain, it was apparent that some of the early plant collectors made collections of superior forms of natural species. Unfortunately, many of these forms have died out and have been lost to

horticulture. Some fine forms of the Victorian heath (*Epacris impressa*) were in this category.

The commonly cultivated, long-flowering form of *Grevillea banksii* is one such selection and although its origin is uncertain, it is vastly superior to the common form of the Queensland southern and central coasts which flowers for only a few weeks.

During the last 20 to 25 years, interested amateurs, enterprising nurserymen, and some institutions have deliberately sought superior forms of species and brought them into cultivation. The National Botanic Gardens, Canberra has carried out extensive field work with this in mind. An outstanding selection in recent years was *Grevillea obtusiflora* 'Little Thicket', a vigorous, suckering plant which has value as a ground cover.

Selections have been made for frost resistance, colour, flower size, shape of bush, multi-petalled forms, etc. but little has been done towards the next step of development of breeding programmes using these selections. This work has been hindered by lack of staff and funds.

Most of the cultivars that have reached the market are the result of chance hybrids and many have little more to offer than either of their presumed parents. Some exceptions exist and such plants as *Grevillea* 'Robyn Gordon', *Grevillea* 'Poorinda Royal Mantle' and *Grevillea* 'Sandra Gordon' show the flora's potential. If well-designed, scientifically based breeding programmes are used, then even greater results are possible.

These techniques have been used with the kangaroo paws (*Anigozanthos* spp.) and such outstanding cultivars as *Anigozanthos* 'Dwarf Delight' bear witness to the value of well considered aims and objectives.

Nutrition. Nutrition of native plants was poorly understood for many years and led to statements that native plants must not be fertilized.

Much of Australian soil is low in phosphorus and the flora has adapted accordingly. Thus when high phosphorus fertilizers were applied to native plants they usually responded by dying. More recently it has been conclusively shown that a positive response can be obtained by application of low phosphorus fertilizers and much work has been carried out in this field by both institutions and study groups formed by the Society for Growing Australian Plants.

Tissue culture and embryo culture. Tissue culture techniques have advanced tremendously since they were used in the early 1960's to produce virus-free carnations and orchids.

Considerable work was done in the 1970's at the National Botanic Gardens, Canberra to expand this technique to propagate kangaroo paws. This is now being done commercially. The propagation of woody plants by this method is still in its infancy but some success has been achieved and some *Grevillea* cultivars are being produced commercially.

The related technique of embryo culture has been used at the National Botanic Gardens to propagate Sturt's desert pea (*Clianthus formosus*) and the beautiful but rare plant, *Hibbertia miniata*. This latter species is endangered in its limited habitat and the application of embryo culture techniques permits many plants to be grown without reducing the wild population.

Grafting. Grafting is not a new technique when applied to native plants, as it was used in Great Britain during the last century in the propagation of Sturt's desert pea. Rootstock of *Colutea arborescens* was used in this case.

Little further work was done with grafting of native plants until the technique was revived by the National Botanic Gardens in 1971. Problems were being experienced with the short life of *Prostanthera* spp. (mint bushes) in cultivation. This was due to the root system being attacked by the root rot fungus, *Phytophthora cinnamomi*.

A satisfactory rootstock was found in *Westringia fruticosa* and the life of prostantheras was substantially extended. Further work with other genera followed and other institutions and interested amateurs began experimenting and extending the range of grafted plants. The technique is not yet being used commercially to any extent.

Export of native plants. In 1979, the Federal Government sponsored an investigation of the potential markets for Australian plant material in the Northern Hemisphere. The results of the investigation were published as a report in 1982 and indicated that an export market existed for potted plants from Australia but the recommended list was small and included only one species from mainland Australia, a palm, *Carpentaria acuminata*. It was also recommended that further study be carried out into the development of native plants from two families, Myrtaceae and Proteaceae. The findings of this report were disappointing and showed a lack of knowledge and appreciation of the flora and its true potential for the export markets. Other surveys have been undertaken to Middle Eastern countries but the export market is still limited and the number of species under consideration for export is still small.

THE FUTURE DIRECTION

Much hard work lies ahead if we are to exploit the full horticultural potential of the Australian flora. Government funding on both a State and Federal level is essential to embark on the research programmes necessary to achieve this.

Continued selection. The flora still conceals many superior forms of species which have not yet been brought into cultivation. Extensive field work is required to seek these clones and allow them to be cultivated in botanic gardens where they will be available for future breeding programmes.

Propagation. A great deal has been done in this field in recent years but still many problems beset us. Seed dormancy is not fully understood and until a species can be grown from seed, plant breeding programmes are impossible. Reliable seed germination still eludes us for *Lechenaultia*, *Persoonia*, *Conospermum*, *Verticordia*, and many other genera, all of which have considerable horticultural merit. Propagation from cuttings is also unreliable for some genera and where clonal characteristics need to be maintained this method must be used unless tissue culture techniques are available. Grafting of many Western Australian species may be the only way that these plants can be grown in the eastern states. More work has to be done to finesse technique, determine optimum timing, and to ascertain the best rootstocks. Tissue culture for woody species, we have said, is still in its early days. This technique may eventually be the final solution to clonal reproduction but many thousands of hours of research will be necessary to determine media composition and type of tissue required for each species involved.

Nutrition and photoperiodism. Further research is necessary, not only to determine the nutrient regime required for optimum growth, but also that required for maximum flower yield. Photoperiodism has been seldom examined for Australian plants but for basket plant production this factor must be considered so that proper controls over flowering may be exercised.

Plant breeding. While further selection, propagation, and nutritional research are basic for continued plant breeding programmes, sufficient material is now available to undertake extensive breeding trials. Efforts should be directed towards the extension of flowering periods, the development of more durable flowers, the production of longer stems, etc., etc.

Farming techniques and disease control. With the practice of field harvesting blooms for the cut-flower market having a limited future from the points of view of quality and conservation, attention must be given to farming techniques. Suitability

of soil types and climate must be determined as well as the previously mentioned nutritional requirements.

Quality of flower and foliage for the export market must be first class or the market will not persist. Leaf-eating insects, leaf-distorting insects, fungal spots on leaves — all must be controlled so that the final product is blemish free. Little is known about the control of pathogens which cause leaf blemishes and much research will be required to overcome this.

Screening for pharmaceutical value. While pharmaceutical screening is not horticultural research, it should be carried out in liaison with the horticulturalists. It is obviously important that when positive reactions are obtained from screening analyses, that this species can be brought into cultivation and preserved for further examination.

LITERATURE CITED

1. Burgmann, M.A. and S.D. Hopper. 1982. The Western Australian Wildflower Industry. Report No. 53, Dept. of Fisheries and Wildlife, Western Australia, Perth.
2. Cribb, A.B. and J.W. Cribb. 1974. Wild Food in Australia. Collins, Sydney.
3. Cribb, A.B. and J.W. Cribb. 1981. Wild Medicine in Australia, Collins, Sydney.
4. Cribb, A.B. and J.W. Cribb. 1981. Useful Wild Plants in Australia. Collins, Sydney.
5. Ellyard, R.K. 1978. In Vitro propagation of *Anigozanthos manglesii*, *Anigozanthos flavidus* and *Macropidia fuliginosa*. *HortScience*. 13(6):662-663.
6. Larkman, B.H. (Ed.) 1982. The Nursery Industry in Australia. A.G.P.S. Canberra.
7. Wrigley, J.W. 1973. Grafting of Australian Native Plants. *Proc. Inter. Plant Prop. Soc.* 23:423-426.
8. Wrigley, J.W. 1982. Potential of Australian Native Plants for the European Indoor Plant Market. *Proc. XXIst Inter. Hort. Congress*. Vol. II 850-861.
9. Wrigley, J.W. and M. Fagg. 1983. *Australian Native Plants*. 2nd Ed. Collins, Sydney.