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Growing Wildflowers

The Use and Conservation of Water

This issue is all about water, its use, its conservation and how to make the most use of the water you are blessed with. The correct use of water is crucial to the cultivation of wildflowers, in fact any horticulture. Comments by readers after reading this issue would be appreciated.

Wildflowers for Horticulture

The Institute for Horticultural Development, a division of the Department of Agriculture of Victoria, is leading the way in horticultural development of our wildflowers. This Institute has a very fine record of assistance to the commercial horticultural industry both for the nurseryman and the commercial cropping for cut flowers. As described on page 166, a small cut flower industry, thriving since the 1930s, was seeking to improve their product and the scientists have not only developed techniques for more reliable flower quality and plant propagation, but they have produced new cultivars as shown in colour on page 168. These are not hybrids but careful selections from wild populations of *Thryptomene calycina*, the Victorian Laceflower.

We want to grow the best forms of plants that nature has evolved and the only way we can do this is by competent selection and marketing these selections under a cultivar name. The overall competence of the Institute for Horticultural Development is illustrated by the advice of where these cultivars may be obtained from a nurseryman, in this case Kuranga Nursery, 393 Maroondah Highway, Ringwood, Victoria 3134.

The dual concern by the Institute for Horticulture for the environment is their work in developing exceptional forms of *Tristaniopsis laurina*, an attractive, useful shade tree (see page 173), and of the Forest She-oak, *Allocasuarina torulosa*, both exceptional landscaping plants. These are also commercially available at Kuranga Nursery and the Institute is even prepared to make available material for grafting on request.

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COVER PLATE — *Nymphoides crenata*. Photography by N. Romanowski.

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Australian Waterplants and Wetland Plants

by Nick Romanowski*
Dragonfly Aquatics, Colac, Victoria

There has been a growing interest in Australian waterplants and wetland plants in recent years, including use in revegetation and recreation of our vanishing wetland areas, but the methods used to grow these plants have been taken mostly unchanged from the terminology and technology used for terrestrial plants. This article is a guide to growing waterplants for those who have not had much experience with them, and suggests using a greater range of waterplants to give a more natural diversity in new wetland plantings.

Waterplants are mostly easy to grow — some can even be quite weedy. The majority of water and wetland plants prefer as much sun as possible and fairly soft water, but a reasonable number of native species tolerate varying degrees of shade and hard, alkaline water.

The soils in which they are planted should resemble old swamp soils, which are very different to the soils we use for other Australian plants. Ideally, waterplant mixes should be moderately rich in organic matter with a source of nitrogen which becomes available very slowly and over a long period of time. Any soils used should also be quite open like those soils we call freely draining on land; most sandy loams are satisfactory.

The addition of 5–10% *well rotted* cow manure with a small amount of blood-and-bone will improve underwater structure and nutrient value of sandy loams, and help to open the structure of clay soils. If the soil is very heavy, mixing in vermiculite or coarse river sand will open it up further and in wetlands which may be above water for part of the summer months the vermiculite will also hold moisture longer than soils with only sand added. Do not worry about blending the “ingredients” too finely as underwater worms will do the same mixing of richly organic soils as on land. If you are planting a large area of clay soil in a dam, vermiculite and similar soil conditioners would become too expensive for use like this; breaking up the top 5–10 cm of clay will allow waterplants to establish quickly enough if some blood-and-bone is worked in.

For submerged species use a layer of propagating sand or fine river gravel to cover the soil so that nutrients do not leach quickly, and the bottom of any pot used should be lined with newspaper to stop the soil from spilling out. Sand to a depth of 3–5 cm is usually sufficient unless you plan to keep catfish or other deep-digging fishes in your pond or dam.

*Over the past few years I have been looking at and growing native waterplants with a very different approach to what is usually done in this country. For a start, my background is in zoology rather than in horticulture. My interest in wetland ecology has led me into growing and handling waterplants in the specialised ways which have been developed overseas in the past 60 or 70 years, rather than trying to adapt the technologies developed for terrestrial Australian plants on this, the driest continent in the world apart from Antarctica! — Author.

Nick is manager and co-owner of Dragonfly Aquatics, a nursery growing the largest range of waterplants in Australia, but specializing particularly in native and edible species. For a mail order catalogue, send two ordinary stamps to RMB AB 366, Colac, Victoria 3250 — Editor.

Water and Wetland Plants for Southern Australia by Nick Romanowski is available for \$24.95. It describes over 600 species and varieties of plants, and their cultivation. If you are planning a water feature in your garden this book provides much valuable additional information.



△ *Nelumbo nucifera*, Sacred Lotus, a native form selected for cold tolerance and flower.

▽ *Ottelia ovalifolia*, Swamp Lily, a double form. The southern equivalent for northern Water Lily. Photographs by N. Romanowski.





△ *Nymphaea gigantea* (blue) and *Nymphoides geminata* (yellow).

Photograph below by N. Romanowski

▽ *Lythrum salicaria*, a plant for waterlogged soil preferring semi-shade.



Avoid synthetic fertilisers (although they will do for many aquatics if alternatives are not available) as they are not formulated for water plant nutrition, so part of their contents simply end up feeding the water. In turn, this can cause unwanted growth of algae (known technically in water gardening circles as "scum"). Synthetic fertilisers are largely mineral salts which many waterplants are poorly adapted to cope with, and do not last a particularly long time underwater in any case because they are designed to dissolve efficiently. Even slow-release pellets will be gone long before the slower-releasing nutrients available from the organic materials suggested.

Perhaps the most important thing to know about any water plant is where it should be planted. Each species is adapted to grow at a particular depth or distance from the water's edge, although most are tolerant of various degrees of flooding or drying out; native species are particularly flexible in this regard and many are even drought-tolerant once they are established. Submerged species may have particular depth preferences, but most are quite tolerant of variations because so many Australian wetlands dry out to varying degrees in summer.

In the case of plants which grow at the edge of the water, it is essential to know which ones will grow in completely waterlogged conditions and which will not tolerate soils which are more than wet. Waterlogged soils are completely saturated so that there are no air spaces in between the soil particles; no oxygen can get into the soil, so it becomes *anaerobic* (lacking in oxygen). Although most truly aquatic plants are adapted to these conditions, others will not survive for long without the small amount of oxygen present in soils which are not completely waterlogged.

Making bog-gardens and watergardens

Bog plants are the easiest waterplants to grow — to accommodate them, simply dig out a shallow pit 20–30 cm deep, line it with heavy-duty plastic and replace the soil after enriching it as described earlier. The liner will last decades underground as it is protected from ultraviolet light, and the odd puncture will not matter as the liner is meant to reduce water loss, not stop it completely. If you plan to grow plants which do not like waterlogging at all, it is a good idea to make extra drainage holes in the liner.

Ponds take more work and care to set up, but can be made quickly these days with flexible liners. The best two liner materials are Butylene and EPDM, both available in flat-black — this gives a more natural appearance and an impression of greater water depth. Both have really long lifespans and guarantees of 15 years or more, but Butylene is much more expensive and offers no special advantages otherwise. Cheaper, non-flexible liners are also available but do not last that long coming mainly in an unnatural range of shades which wash out the colours of fish and plants and make water look shallow. In particular, avoid vinyl liners as these are short-lived in sunlight and almost impossible to repair if punctured.

To make a liner pond just excavate a hole of the desired size, making sure that the sides are level. Stretch the liner loosely across the excavation, weigh the sides down with bricks and fill it slowly while paying out the flexible liner as required so that it settles snugly and neatly into the pond. Working out liner dimensions is easy — double the length and add twice the maximum depth, then repeat for the width to get the other dimension.

Special drainage arrangements should not be necessary as a well-established pond does not need to be cleaned often apart from removing detritus, and any small water-changes can be done by flushing with a hose. However, if the pond is in a naturally boggy spot, you will need to put in drainage *outside* the pond or the liner may float up in wet weather as the water table rises beneath it. I am not going to go into complex subjects like choosing a site for your pond, but do keep in mind that it could be as much of a hazard for very small children as a backyard swimming pool.

Fibreglass ponds have been superseded by pond liners although you would not know it from the number still sold by general nurseries — they take a lot more work to set up than a liner pond of the same size, come in unimaginative and restricted shapes, do not have as long a warranty, and cost more for the same volume of water. I must admit that I use mainly fibreglass ponds in my water plant nursery, but these are rigid units designed for above-ground use and maintenance rather than as ornamental ponds.

Concrete ponds are an economical proposition if you are already well experienced in working with concrete, but amateur-made concrete ponds *often* develop cracks which are difficult to repair or even locate (the most reliable repair for a leaking concrete pond is to reline it with a flexible liner!). A professionally made concrete pond will cost more than a liner pond, and it can take months of special curing treatments to make it suitable for fishes or plants.

However your pond is made, include planting shelves at appropriate depths for the plants you wish to grow. These can be covered with soil, then river gravel for direct planting, or have pots placed on them if you intend to grow everything in containers. Remember that the planting depth for submerged plants is measured from the water's surface down to the top of the gravel on the shelf or in the pot, and not down to the shelf itself.

A Chinese proverb says "Where there is water there should be fish", and nothing could be more true. Fish add life and interest to a pond, and will eat any mosquito larvae which appear in the water. Goldfish are most commonly used in ponds but stir detritus up constantly, and are brightly coloured so they attract herons, cormorants and cats. Native fish are more appropriate for an Australian water garden, and are not likely to be caught by predators. A few species have been available from aquarium shops in recent years, but you can also catch your own in many areas. Around five smaller fish are all you need for a small pond, while 20 to 30 will crowd anything except a really big pond. However, bear in mind that some native fishes are fully protected in some states, and make sure you can recognise what you catch or you will probably end up with the noxious and aggressive Mosquito fish (*Gambusia affinis*), which has spread everywhere since its ill-planned introduction.

Aquatic Plant Study Group? As suggested by Nick Romanowski on page 149, readers may wish to form a Study Group to learn more about Australia's aquatic plants. Study Groups operate by correspondence and are ideal for members who feel remote or isolated. Interested people should write to the Study Group Co-ordinator, Jan Sked, P.O. Box 41, Lawnton, Queensland 4501.



△ *Ludwigia peploides*

Photography by N. Romanowski

▽ *Mimulus gracilis*



Australian plants for particular situations

The lists below are not meant to be exhaustive;* they are mainly a summary of the more readily available water and wetland plants at present, and a guide to appropriate planting conditions. These conditions are based on my own experiences in southern Australia, but the more tropical aquatic species can often be planted deeper in northern Australia. For example, the Sacred Lotus (*Nelumbo nucifera* — photo: page 144) is best grown in shallow water in cooler climates so that the water and soil have a chance to warm up quickly enough to give a reasonably long growing season. There are hundreds more species, varieties and forms I have yet to grow, and I would welcome correspondence with other SGAP members growing water plants for this reason; perhaps an Aquatic Plant Study Group could be formed.

Deeper Water: preferably at least 20 cm depth, but few true aquatics will do well at depths greater than 1 m. Plants preferring these conditions include:

Brasenia schreberi, photo page 181 (Water-shield — unusual, oval, floating leaves), *Chara* and *Nitella* spp. (Stoneworts — algae with crystalline stems), *Chara fibrosa* (Feathery Stonewort — apparently able to clear clay-coloured dams), many *Myriophyllum* spp. (Water Milfoils — feathery leaves under water, different foliage above), most *Potamogeton* spp. (Pondweeds — translucent underwater leaves), *Vallisneria* spp. (Eelgrass or Ribbongrass — strap leaves).

Deep or shallow water: a surprising number of species listed will survive drought. They usually die away until conditions are favourable for growth again.

Marsilea mutica (Rainbow Nardoo — floating, four-leaf clover leaves), many *Myriophyllum* spp. (Water Milfoils — my favourite in this category is *M. papillosum* “Red Dragonfly”, photo page 160, with crimson leaves through spring), *Nymphoides* spp. (Marshworts — leaves like small water lilies, fringed flowers), *Ottelia ovalifolia*, photo page 144 (Swamp lily — floating leaves, showy white flowers), some *Potamogeton* (Pondweeds), some *Ranunculus* spp. (Buttercups — most quite different from the plants familiar under this name), *Triglochin procera* (Water ribbons — floating or upright, strap leaves).

Shallow water or waterlogged soils: nearly all these plants will tolerate soils which are only wet, but some of them grow best only when they are saturated.

Alisma plantago-aquatica (Water plantain — upright stems topped with heart-shaped leaves), *Amphibromus* spp. (Swamp wallaby-grasses), many *Baumea* spp. (Twigrushes — very variable but interesting stems), *Bolboschoenus* spp. (River bamboos), several *Callitriche* spp. (Starworts), many *Carex* spp. (Grassy sedges), some *Cyperus* spp. (Leafrushes), *Damasonium minus* (Starfruit), *Elatine gratioloides*, most *Eleocharis* spp. (Spikerushes), *Glyceria australis* (Australian Sweetgrass), some *Juncus* spp. (Reeds), *Lepidosperma longitudinale*, *Lilaeopsis polyantha*, *Ludwigia peploides*, most *Marsilea* spp. (Nardoos), several *Mimulus* spp. (Monkeyflowers), *Montia australasica* (Water purslane), *Nelumbo nucifera* (Sacred Lotus), *Persicaria decipiens*, *Philydron lanuginosum* (Woolly lily), *Phragmites* spp. (Common reed — also tolerant of deeper flooding), many *Ranunculus* spp. (Buttercups), *Schoenoplectus* spp. (Club-rushes), *Typha* spp. (Cumbungi — also tolerant of deeper flooding, but invasive and not recommended except for specialized purposes), *Villarsia* spp. (Marshflowers).

***Water and Wetland Plants for Southern Australia**, a book by the author of this article, describes over 600 species and varieties of plants, giving advice on their cultivation. The book is available from your bookseller for \$24.95.

Waterlogged soils*: all the plants in this section are also happy enough on soils which are only wet, and most do not mind periods of deeper flooding. Other species and varieties not listed will tolerate seasonal waterlogging, but prefer to be drier for most of the year; these can also be grown with their roots mostly submerged year-round so oxygen is freely available to them (for example, many *Callistemon*).

Many *Baumea* spp. (photo page 161), several *Blechnum* spp. (Waterferns) many *Carex* spp. (Grassy sedges), *Chorizandra enodis* (Echidna rush), *Cyclosorus interruptus*, many *Cyperus* spp. (Leafrushes), *Dicksonia antarctica*, many *Epilobium* spp. (Willowherbs), several *Gleichenia* spp. (Coral ferns), *Gratiola peruviana* (Austral Brooklime), *Gunnera cordifolia* (Tasmanian Gunnera), *Bracteantha* sp. aff. *subundulata* (previously *Helichrysum acuminatum* Swamp everlasting), many *Isolepis* spp. (Clubrushes), *Lycopodium australis* (Water horehound), *Lythrum salicaria* (photo page 145) (Purple loosestrife — also can grow in shallow water), many *Mimulus* spp. (Monkeyflowers), *Restio tetraphyllus* (photo page 181) (Tassel cordrush), *Rumex bidens* (Water dock), *Samolus repens* (Creeping Brookweed), some *Schoenus* spp. (Bogrushes), *Sticherus tener*, *Todea barbara* (Kingfern), *Triglochin striata* (Streaked arrowgrass).

Floating plants: the roots of these plants do not need to contact soil; indeed, some do not even have roots.

Azolla spp. (Fairy fern), *Ceratophyllum* spp. (Foxtail or Hornwort), *Lemna* spp. (Duckweeds), *Riccia* spp. and *Ricciocarpus natans* (Floating Liverworts), *Spirodela* spp. (Duckweeds), some *Utricularia* spp. (Bladderworts), *Wolffia* spp. (Duckweeds).

Native Water Lilies: no Australian *Nymphaea* species or forms I have tested will grow well (let alone flower) much south of Queensland without extra heat; most of them also resent being transplanted more than the non-native species and hybrids more commonly seen. If you are growing native *Nymphaea* in the tropics, transplant them only when they are actively growing (preferably at the beginning of their growing period). Take large divisions if possible so you can plant the larger species as deep as 1 m immediately, because they dislike shallower water. All species are easily grown from seed planted in shallow water, moving the young plants deeper as they increase in size.

There are several substitute species which can be more easily grown in southern Australia. *Ottelia ovalifolia* (Swamp lily, photo page 144) has large, white, three or four-petalled flowers with a colourful centre; the floating leaves are oval, richly coloured and attractively veined. *Brasenia schreberi* (photo page 181), is related to true water lilies but the deep-purple flowers are relatively small, and the floating leaves are an unusual shield shape. *Nelumbo nucifera* (Sacred Lotus) is found in northern Australia as well as across Asia. Despite being such a tropical plant in distribution, at least one native form is surprisingly cold-tolerant if you go to the trouble of establishing it properly in its first growing season. This form (photo page 144), has flowered from January to March here in southern Victoria even in the very cold summer of 1991–92 and needs no winter protection. Unlike most other warmth-loving Australian plants which will not survive wet winters, it cannot be drowned no matter how much rain falls!

***Water Logged Soils or Wet Soils?** "Australian Plants For Wet Soils" is a separate article on page 158. This important subject is developed further as it covers many difficult situations met in a garden.

Drought-tolerant plants: all the categories above are artificial in the sense that many of the plants listed will grow in drier conditions, but may die away during really dry conditions and not regrow until permanent water is available again. Some of the more ornamental examples of drought-tolerant plants include various *Myriophyllum*, *Juncus*, *Marsilea*, *Ranunculus*, *Typha*, *Pater-sonia*, *Epilobium*, *Craspedia*, *Villarsia*, and also quite a few reeds, rushes and sedges including some *Cyperus*.

Cold-climate and alpine wetland plants: Australia is mainly a low-lying country with limited alpine and sub-alpine areas. Few people live in sub-alpine areas, and few truly aquatic plants are found here because ponds are not very common and may freeze for many months. On the other hand, water can be abundant in the spring thaws, large areas being saturated with very cold water which is always moving so that soil has no chance to become anaerobic. Such plants may be too specialised to grow well in warmer or lowland areas, a further problem being that they should be protected from summer heat, yet are used to an intense amount of light in their exposed habitats.

Although no nursery seems to specialize in plants for high alpine conditions, some species are available on occasion in cooler areas. Those which will definitely grow in cooler lowland areas include *Blechnum penna-marina* (Alpine waterfern), *Caltha introloba*, *Diplarrena latifolia*, *Gunnera cordifolia*, several *Milligania* spp. (Milliganias), *Montia australasica* (Water purslane), *Nertera granadensis*, *Ranunculus collinus* (Strawberry Buttercup) and *Ranunculus muelleri* (Alpine Buttercup).

Other species may be less tolerant of warmer areas, and not enough is known about how to grow them away from their natural habitats. The following plants have been available occasionally, but success may depend on individual clones or populations being more adaptable than others: *Asperula gunnii*, *Brachyscome nivalis*, *Caltha phylloptera*, *Dracophyllum minimum* and *Luzula alpestris*. For those people living in sub-alpine areas the choice of suitable plants will be much greater, but seed or cuttings will be the only way to obtain most species — with the necessary permits, of course!

Tropical water and wetland plants: many of the plants listed before will also grow happily (and often occur) in the tropics. These include: *Azolla pinnata*, *Brasenia schreberi*, many *Carex* spp., *Ceratophyllum demersum*, all *Chara* spp., many *Cyperus* spp., *Elatine gratioloides*, *Eleocharis sphacelata*, *Glyceria australis*, several *Isolepis* spp., many *Juncus* spp., all *Lemna* spp., *Ludwigia peploides*, several *Marsilea* spp., *Nelumbo nucifera*, all *Nitella* spp., *Nymphoides crenata*, *Ottelia ovalifolia*, *Persicaria decipiens*, *Philydrum lanuginosum*, both *Phragmites* spp., several *Potamogeton* spp., *Restio tetraphyllus* (ssp. *meiostachyus*), some *Schoenoplectus* spp., some *Schoenus* spp., *Triglochin procera*, *Typha domingensis*, all *Vallisneria* spp.

There is a wide range of truly tropical Australian water plants, some of which will adapt to cooler climates. More tolerant tropicals include *Nymphoides indica* and the native form of *Colocasia esculenta* (Taro). Tropical water and wetland plants in Australia are not well known at present, although much new research is being done to sort out what really is up there. Even fewer of these plants have been cultivated, usually under a miscellany of names which are often out of date or irrelevant. For example, many different water lilies have been jumbled under the name *Nymphaea gigantea*, but a paper recently published separates out a number of species.

One thing is clear, though; the tropics hold a number of attractive, distinctive and unusual Australian waterplants which will be well worth growing when they become available. Even at the present time some of these are available occasionally through aquarium shops including *Aponogeton* spp. (Laceplants), *Ceratopteris thalictroides* (Lace fern), several *Monochoria* spp. (Monochorias), *Ottelia alismoides*, and the occasional *Nymphoides* (most Marshworts are tropical, including many with very ornamental leaves or flowers).

Diversity and local provenance

Increasingly, growers of Australian plants are using locally provenanced plants for gardens and revegetation. Many terrestrial plants vary considerably across their range and develop localised populations well adapted to their local conditions; often these populations have special importance for the local fauna as well. Many such populations have vanished completely since European settlement and it is important to keep those which are left. However, using only "local" waterplants for revegetation has the effect of *reducing* diversity in new wetlands and water gardens for two reasons.

For a start, the more common waterplants today are a select band. Many are just as good at invading disturbed areas as any non-native weed, and they are also adapted to travelling over great distances with the aid of wind or waterfowl. Such plants are not locally adapted, as those which appear from seed in a nearby dam may have originated hundreds of kilometres away. Their most important adaptation is to be able to spread as far and as quickly between wetlands as possible because they cannot travel overland.

Some obvious examples of such widely ranging plants include *Eleocharis sphacelata* and other smaller *Eleocharis* spp., *Ottelia ovalifolia*, *Philydrum lanuginosum* (paradoxically, now quite rare in southern Australia because cattle like to eat it), *Myriophyllum verrucosum*, *Phragmites australis* and *Typha* spp., but there are many others. Quite a few of these are found across most of Australia, even from the Kimberleys to Wilson's Promontory; some even extend into Asia and the Pacific. How many other Australian plants cover such extraordinary ranges without much variation?

By contrast, many other waterplants are not good at spreading from one wetland to the next, so they are often endangered by grazing, drainage or invading weeds. Countless wetlands have been drained in the last 200 years (no one even knows how many there were originally), and now such plants are less likely to be able to spread to another wetland because of the even greater distances between these today. If conditions in their last refuges cease to be suitable, they may now vanish without the chance of re-establishing in other areas where conditions may have become more suitable for them.

Many such localised populations may have vanished without record because of the difficulty of finding them. No one has paid waterplants much attention until the last few decades, so even now the main job is still to identify and name those which are left. I suppose the moral of this section is, include a few of these apparent never-do-wells when you plant even if they do not occur in your immediate area. They may have been around unrecorded in the past, and they were certainly doing very well until we came along and changed their world beyond hope of repair. ■

Wildflowers and Water

by Dr John Marshall
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Wildflowers and water conjure up many issues.

How much water do wildflowers require; how little will they survive on: how will they respond to more than usual? Is water use in a garden predominantly planted with native species lower than in an English-style garden? How have wildflowers adapted to survive long, rainless periods in the bush?

These questions are not going to be addressed directly. Instead, I want to look at the processes underlying wildflowers and water, and how technology is allowing us to understand water uptake better. The research which lies behind this account of wildflowers and water is done to answer two kinds of question.

How does water affect plant growth is the more traditional question. The research is aimed at improving the efficiency of irrigation of Australian wildflowers, such as Geraldton Wax, being grown in the floriculture industry for export.

The second question turns the traditional question round and asks: how does vegetation affect water resources? This research is being applied to aspects of water yield from catchments in the Jarrah forest of south-west Western Australia where water uptake by Jarrah and Marri is being investigated. It is also being applied to water quality aspects in cleared land where tree plantations are used to lower salty groundwater tables or where effluent is being disposed. In that context, water uptake by trees in River Red Gum and Tasmanian Blue Gum plantations is being studied. Another application of the water uptake ability of vegetation is to speed up the drying out of mine tailings dams.

The Demand for Water and its Supply

In southern Australia, the atmosphere has the potential to demand water at amounts varying from about 1 litre for every square metre of ground in winter, to about 10 litres for that same area in summer. It may not actually have that demand met. Any shortfall means surplus energy which, instead, is used to heat the surface and the air.

Water comes primarily from rain. But many things may happen before it is available for the plants to deliver that water to the atmosphere.

The rain may never reach the ground, being caught up, instead, in the crowns of plants and evaporated from there to satisfy atmospheric demand. That which reaches the ground may do so faster than all of it can enter. Part, then, runs off the surface. The rain water which gets into the soil — and that may be quite a small proportion of the rain which falls — is stored in the spaces between the soil particles. About half of the soil volume is available for storing water, so 1 mm of rain would saturate 2 mm depth of soil.

A tussle between gravity and the tenacity with which the water is held in the soil follows. As a result, anything up to 85% of the water at saturation soon drains down the soil profile. The amount of water left varies greatly with the type of soil. More is retained after drainage in clays — about 30% of the soil volume — than in sands where less than 10% of the soil volume may be left containing water.

Availability to Plants

Not all of that water stored in the soil after drainage is available to plants. Their fine absorbing roots must be present. Prodigious lengths of roots under plants have been reported. One of the more frequently quoted is that of 500 km of root on a 16-week-old winter rye plant. Yet perhaps we should not be too surprised at this. To have a root present in every cubic centimetre of a cubic metre of soil requires 10 km of root. Not only density but the depth of rooting is important as it determines the maximum volume of water available to the plant.

Presence of roots capable of absorbing water is only part of the story of what water is available to plants, however. The other is the tenacity with which the water is held in the soil. Plant roots can retrieve only some of the water. The remainder stays in the soil. The water retrievable by plants — called available water — again varies with soil type. It is lowest in sands — only some 6% of the soil volume, whereas in clays it may be as high as 20% of the soil volume. In potting mixtures using perlite, vermiculite and the like, the available water can be even higher.

Returning to our square metre of ground, and going to a depth of one metre: after drainage has taken place, a sand then contains about 60 litres of available water, a clay, about 200 litres. In theory, that storage would be sufficient for a plant to meet atmospheric demand for 60 to 200 “winter” days — but only 6 to 20 summer days. This implies a problem for survival in the summer indicating the need for control of water loss.

How Water Moves

We have a picture of supply and demand for water — but how does that water move? After all, we require it to move *upwards* from the soil to the atmosphere, yet know that apples fall *downwards*. Clearly, some force other than gravity, and greater than it, is operating. That force can be thought of as the tenacity with which water is held and the ability of the competing components, the soil and the plant, to wrest the water from one to the other. Rather like a child tussling to pull away something held by another. Water is held tenaciously in the soil, but in the leaves and stems from which it is being evaporated, an even greater demand is created. As long as this disparity exists, and there is a continuous connection of water from the soil to the leaf or stem, water will be wrested from the soil and move up the plant.

Although that usually means an upward journey, hydraulically, it is downhill — down a gradient from a less retentive force to a greater retentive force. As the soil dries out, water in it is held more tenaciously. And in response, the retentive force in the plant increases to maintain the gradient so that water continues to be taken up. But that plant response can only go so far. Eventually, no more adjustment is possible. The water remaining in the soil adjacent to the roots is held too strongly, a condition which, if persistent, is sometimes called the wilting point.

The equivalent forces are formidable. Water is held in the soil at wilting point with a force equivalent to seven times greater than the pressure you inflate your car tyres to. To overcome the resistances to flow of water from the soil, water in the leaves of a tall tree at midday may be held at a force equivalent to over 14 times greater than your car tyre pressure. But the gradient would not exist were it not for the ultimate demand. Air surrounding the plant at a humidity of 50% has a retentivity equivalent to 480 times car tyre pressure!

Control of Water Loss

In Western Australia, the rainy season finishes in October–November and begins again in April–May. Little rain falls for six to eight months. From our earlier calculations of water storage in the soil, there is clearly an inadequate supply of available water to meet atmospheric demand over the summer months. Plant survival requires control of water loss.

All plants, to varying degrees, do this on a daily basis. The pores — stomata — through which the water vapour escapes to the atmosphere (it has already been vaporised within the plant leaf or stem) open in response to light. With increasing atmospheric demand during the day, water loss from the plants tends to exceed the rate at which water can be removed from the soil. As a result the retentivity of water by the plant increases as it becomes more deficient in water, and water uptake continues. A point is reached, however, usually around the midday hours, when the pores close, restricting water loss while allowing the slower uptake to continue. It is not unusual for recovery of plant water content to have been sufficient by late afternoon for the pores again to open and remain so until their closure as darkness falls.

Stomatal closure, then, allows some daily control of water loss — effective enough for the plant to yield only three litres of water per square metre of ground on a day when the atmosphere demands 10 litres. This control alone means that the water supply in the top metre of soil is sufficient to last 18 to 60 days instead of the estimated six to 20 days in the absence of such a control; still short of the 180 to 240 days of the W.A. dry period.

Adaptations for Survival

Further controls of water loss are clearly necessary if survival is to be achieved. These are often called adaptations with three options existing in the strategy for survival, the supply, the demand and the storage of water.

Supply of Water — On the supply side, the adaptations are less obvious because they are out of sight, below ground. They include depth and density of root system, pattern of root extension, perennality of root system and the ability to take water from near water tables. The simple expedient of extending rooting depth to two metres, for example, may allow survival to extend to 36 to 120 days — approaching sufficient to last out the worst of the summer heat.

Demand for Water — More obvious are adaptations above ground. These are aimed at reducing the demand by intercepting less direct sunlight or by making water loss less easy. Some plants are leafless, some drop their leaves, some shrivel up completely and over-summer as below ground parts or as seed. Others, while retaining their leaves, reduce the direct sunlight they intercept by hanging vertically, tracking the sun by turning edge-on during the day, folding or rolling up, or changing the leaf (and leaflet) angle so that they go from spreading to clasping. Some leaves do none of these things. Instead, they reflect much of the sunlight by being near-white. Or they make water loss more difficult by retaining a layer of still air at the leaf surface in an entanglement of hairs. Another variant of this strategy is habitat: the plants grow in shady places.

These adaptations can be very effective in reducing the demand for water and ensuring survival. The light-transmitting canopies of Australian eucalypt woodland are often remarked on in contrast to the deep shade cast by rain-forest and temperate deciduous forest canopies.

Storage of Water — The third option, that of internal storage of water, appears limited because of the size of the demand and the capacity of the plant to store water. A three-month summer period with a demand of 10 litres per day per square metre of ground equates to nearly 1 cubic metre of water. Assuming, that to survive, a plant could only tolerate a maximum of 10% decrease of its water storage, this implies a storage of nearly 10 cubic metres. Given a storage structure accommodating 50% of its volume as water, these calculations imply a storage facility of 20 cubic metres on a square metre of ground. That is, a structure 20 m high! Adjustments to components of that water storage calculation indicate storage can, however, serve as a survival option. Examples include succulent plants with much more than 50% of their volume occupied by water and capable of withstanding a decrease due to desiccation greatly exceeding 10%. Some trees exhibit obvious water storage features such as the trunks of boabs, and the Western Australian Christmas Tree, *Nuytsia floribunda* with watery trunks and succulent leaves.

The Wood of the Trees — Large storage capacities are not necessary if frequent topping-up is possible. And that brings us to “ordinary” trees, and one of the ways in which they are notably different from grasses and herbs. When a new day dawns, the water lost by a tree to the atmosphere doesn’t come from the soil — it comes from the store of water in the tree. As the day goes on, the bulk of that water may be replaced from the soil before the stomata close but some of the replacement from the soil occurs after stomatal closure. On a long, hot, summer’s day, with late afternoon opening of stomata, the tree may end the day with its internal water store depleted. Replenishment of that store comes after dark when, with stomata closed, the gradient of tenacity by which water is held is from the soil to the tree — sufficient for water uptake by the tree to continue for some hours after dark.

Conclusions

Are gardens mainly planted to species native to Australia likely to require less watering than English-style gardens? By and large, particularly if the species in question come naturally from areas with long, rainless periods, the answer is likely to be “yes”. But probably for a combination of reasons. Often, the species are woody rather than herbaceous; deep-rooting (and hence having access to more water) rather than shallow-rooting; they are often small-leaved or leafless and reduce their leaf area exposed to direct sunlight when droughted. Such gardens will require less watering for survival of the plants. Whether they **use** less water, when it is made available, is not so easy to answer! With new advances in technology, “Wildflowers and Water” is a subject we will continue to hear a lot about in the coming years following current research.

Acknowledgements

Kandiah Analapoopathy of Murdoch University, Department of Horticultural Science, kindly made available results from his research on water relations of Geraldton Wax, as did Dr Stuart Crombie of the Western Australian Department of Conservation and Land Management (CALM) Research Station at Dwellingup from his research on water relations of Jarrah and Marri.



△ *Craspedia globosa*

Photography by N. Romanowski

▽ *Utricularia gibba*



Australian Plants for Wet Soils

by Nick Romanowski*
Dragonfly Aquatics

*There are probably hundreds of Australian plants which will grow in soils which are wet, but not waterlogged. In this article I will look at the cultivation of a few which I have grown in the cool climate of southern Victoria. Larger shrubs and trees have been deliberately left out — *Callistemon*, *Melaleuca* and others which grow naturally in wetlands are well known to many readers.

Factors, apart from wetness, affect the growth of plants in wet soils, in particular temperature. For example, Green Kangaroo Paw (*Anigozanthos viridis*) is reputed to tolerate waterlogging for periods of time, but in a cold climate is prone to root-rot if kept too wet for too long. By contrast, Tasmanian Gunnera (*Gunnera cordifolia*) dislikes long, hot summers and only grows reliably in southern Australia, or in sub-alpine areas further north.

However, waterlogging is probably the most serious problem for plants grown in wet soils — there is a great difference between wet and waterlogged. **Wet soils** are not completely saturated so oxygen can penetrate the air spaces within the soil. In **waterlogged soils** these air spaces are flooded, so oxygen does not penetrate far and the soil becomes *anaerobic* (lacks oxygen). Anaerobic soils have a different chemistry from terrestrial soils which may adversely affect some plants, but more importantly plant roots need some oxygen to grow. Aquatic and semi-aquatic plants are usually able to transport oxygen from the foliage down to the roots, or may anchor themselves very shallowly so that the roots do not reach the anaerobic zone of soil.

The practical effects are simple enough — aquatic and semi-aquatic plants will grow in waterlogged soils, and many will continue to grow even in soils which are only wet. However, more terrestrial plants which are happy enough even in very wet soils may not survive more than a few days of waterlogging. I have used this simple biological division to split the plants described below into two groups, the second of which should not be planted in wet sites which are likely to become waterlogged for more than a short period of time.

True wetland plants which will grow in wet soils are perfectly happy even in situations where waterlogging may last for weeks, or even permanently.

Some are grown for their **carpeting effect**. Swamp Stonecrop (*Crassula helmsii*) forms a thick, rather mossy-looking carpet able to smother weed seedlings before they can reach light. *Callitriche muelleri* is a rare prostrate with tiny leaves, while *Gunnera cordifolia* forms packed mats of larger, dark-green foliage. *Elatine gratioloides* is best as a submerged aquatic, but will also form a sprawling carpet when established above water.

Other foliage **groundcovers** include Knotweeds such as *Persicaria decipiens* with leaves patterned with purple-red blotches, and the spearhead-leaved *P. praetermissa*. Both species have attractive columns of pink flowers. The foliage of Water purslane (*Montia australasica*) is narrow and succulent; on wet soils this plant will form a compact lawn spangled with white flowers. All "forms" of Swamp Isotome (*Isotoma fluviatilis*) are attractive carpeting plants which may be covered in white, lilac or blue flowers. Maori musk (*Mimulus repens*) forms a dark green carpet, with prominent yellow-centred, pink flowers. *Ludwigia peploides*, photo page 148, is almost too tall to be called a groundcover — the glossy leaves are an attractive background for the equally glossy, yellow flowers which resemble buttercups.

Many ferns are very water loving, including low-growing ones such as Common nardoo (*Marsilea drummondii*) with furry, four-leaf clover leaves, and the unnamed miniature species once confused with *M. angustifolia*. *Blechnum penna-marina* is a low-growing, sub-alpine water fern, but others of this genus are even more water loving and grow much taller, particularly *B. indicum* and *B. minus* which forms a miniature trunk. *Dicksonia antarctica* is a true Treefern which will grow in waterlogged soils so long as the water is moving — some oxygen is still available in the soil while the water still flows. King fern (*Todea barbara*) is virtually a true aquatic which is sometimes thought of as a Treefern because of its massive, rounded trunk.

Other wet-loving ferns may form sprawling colonies, sometimes by spore but more usually by scrambling. These include the pale green Bat-wing fern (*Histiopteris incisa*), *Cyclosorus interruptus* and Coral ferns (*Gleichenia dicarpa* and *G. microphylla*) are probably the most frequently grown. More tropical species include Climbing Swamp fern (*Stenochlaena palustris*), a very attractive twiner which will not tolerate frost. *Angiopteris evecta* and *Marattia salicina* are closely related, large and dramatic swamp dwellers which must not be allowed to dry out. Although both will grow in frost-free locations in southern Australia, they are best kept less wet during colder weather.

Sedges, reeds and similar grassy plants are generally associated with water, and many species are ideal for wet soils which may flood. Tassel cordrush (*Restio tetraphyllus*) is probably the best known in cultivation, but Common reed (*Phragmites australis*) is more familiar to most Australians as it is so widespread. Many *Carex* species prefer wet to waterlogged conditions, particularly *C. appressa*, *C. gaudichaudiana* and *C. tereticaulis*, as do many Leafrushes including *Cyperus gymnocaulos*, *C. lucidus*, *C. mirus* and *C. vaginatus*, which vary from tiny, slender-leaved tussocks to strap-leaved thickets topped with coppery flowerheads. Some *Baumea* species grow best in wet or waterlogged soils, the most decorative of which are *B. juncea* with waxy-blue, upright stems and the curious *B. tetragona* with four-sided stems.

The leafier reeds such as *Juncus caespiticius* form attractive, grassy swards topped with fine, open flowerheads, and *J. planifolius* will turn quite red in sunlight. If you are looking for a no-maintenance lawn for a really wet situation the smaller, fine-leaved *Isolepis* species such as *I. subtilissima* will form thick, lush carpets which actively compete with weedier species. Some *Schoenus* species can be used in a similar way, my favourite being *S. maschalinus* which must be the most perfect lawn of all; it is a dense, fine, fast-spreading carpet which rarely grows high enough to be mown.

Some larger wetland plants will also adapt well to wet garden situations, for example, the curious Woolly lily (*Philydrum lanuginosum*) with columns of yellow flowers above the fleshy, iris-like leaves. Showy willowherb (*Epilobium pallidiflorum*) is inconspicuous until the pale lilac flowers appear when it can be seen even from across the width of a dam. Water horehound (*Lycopus australis*) is a dense-growing shrub with great potential in landscape as a foliage plant, while Purple Loosestrife (*Lythrum salicaria*, photo page 145) is not very interesting until the columns of pinkish-blue flowers appear. Swamp Everlasting (*Bracteantha* sp. aff. *subundulata*, previously *Helichrysum acuminatum*) will grow and spread in any wet soils, or even float out into deeper water if grown at the water's edge.



△ *Azolla filiculoides*, lime coloured plant on the left and *Azolla pinnata*, rusty coloured on the right.
 ▽ *Myriophyllum papillosum*, Red Dragonfly, a selected form with bright-crimson leaves





△ A medium-depth pond in full sun featuring *Baumea juncea* (reeds front LH), *Carex bichenoviana* behind rock (front LH), *Chorizandra enodis* (clump LH side), *Marsilea mutica* floating on pond behind *Potamogeton tricarlinatus*, floating with white flowers in front.

▽ *Baumea articulata*, Bamboo Reed, a tall reed with big tawny flower heads — water fowl habitat.



Quite a few of the plants described so far will also grow in shaded situations including *Angiopteris evecta*, *Blechnum minus*, *B. penna-marina*, *Callitriche muelleri*, *Carex bichenoviana* and *C. gaudichaudiana*, *Cyperus lucidus* and *C. vaginatus*, *Dicksonia antarctica*, *Elatine gratioloides*, *Histiopteris incisa*, *Isolepis subtilissima*, *Isotoma fluviatilis*, *Juncus caespiticius* and *J. planifolius*, *Ludwigia peploides*, *Lythrum salicaria*, *Marattia salicina*, *Marsilea drummondii*, *Persicaria decipiens*, *P. praetermissa*, *Philydrium lanuginosum* and *Schoenus maschalinus*.

More terrestrial plants which will grow on wet soils are usually less tolerant of waterlogging, as many of those described below are only adapted to wet climates or the very fringes of wetlands. Many of these are ground-covering species such as the sprawling *Alternanthera denticulata*, Buttercups such as *Ranunculus undosus*, native Violets (*Viola betonicifolia* and *V. hederacea*), and even some *Goodenia*s including the showy-flowered *Goodenia elongata*.

Other groundcovering species are much smaller leaved. Bead plant (*Nertera granadensis*) forms dense carpets covered in orange berries in summer, while *Mazus pumilio* has rather scalloped leaves and relatively large lilac-blue or white flowers. *Pratia* species have small, rather ivy-like leaves and white or blue flowers, but can be rather invasive; *P. darlingensis*, *P. pedunculata* and *P. purpurascens* are all cultivated.

Many ferns prefer wet soil for good growth, in fact, so many that I will only mention a few of my favourites. Water ferns (*Blechnum*) have already been mentioned as true aquatic plants, but several species are less tolerant of waterlogging including *B. fluviatile* and *B. nudum*. Maidenhairs (*Adiantum*) are too well known to need description; *A. aethiopicum*, *A. cunninghamii* and *A. formosum* are three of the most distinctive, easy to grow and widely available species suited to wet soils. Fan ferns (*Sticherus*) need constantly moist to wet soils, but *S. tener* is usually the only one available.

Grassy and reedy plants are not confined to watery habitats — there are dozens of species which will look most attractive grown in wet soils. Sedges such as the giant tussock-forming *Gahnia sieberiana* can dominate the fringes of wetlands and are also surprisingly drought-tolerant, while others (equally hardy) such as *Carex bichenoviana* are much smaller growing and will form grassy carpets with time. Reeds (*Juncus*) are particularly common in areas which may dry out in summer, but only look their best in permanently moist or wet soils; examples include *J. pallidus*, *J. pauciflorus* and *J. sarophorus* which form neat tussocks but may spread further from seed.

There are probably hundreds of other plants which tolerate drying out in summer, but grow and flower best when water is constantly available. These include some Purple-flags (*Patersonia*, particularly *P. fragilis* and *P. occidentalis*) and both Butterfly-flags (*Diplarrena latifolia* and *D. moraea*) which form grassy tussocks with rather iris-like flowers in purple or white. Other water lovers such as the fragrant Mints (*Mentha australis* and *M. diemenica*), Woodruffs (particularly *Asperula gunnii* and *A. subsimplex*), and a number of daisies (for example, Swamp daisy — *Brachyscome cardiocarpa*) are not frequently available, but are well worth growing if you can obtain them.

However, not all Australian plants which prefer wet soils are hard to find. The Kangaroo Paws (*Anigozanthos*) include species which grow best with constant moisture, particularly *A. flavidus* and *A. viridis* although some of their hybrids may prove to like such conditions too. *Artanema fimbriatum* is a widely available shrub with showy, purplish flowers, but it can be killed by even a light frost. The various forms of River or Dog Rose (*Bauera rubioides*) are too well known to need description. By contrast, the Billybuttons (*Craspedia*) seem to be unfamiliar to many gardeners despite the wide availability of *C. globosa*. Several of the Flax-lilies (*Dianella caerulea*, *D. tasmanica* and perhaps some forms of *D. longifolia*) with rich-blue flowers and berries are also tolerant of wet conditions.

Some of the more terrestrial plants just described will do well in shaded sites, or even look better if protected from the hottest sun. These include all three *Adiantum* species mentioned, *Blechnum fluviatile*, *Carex bichenoviana*, *Dianella tasmanica*, *Juncus sarophorus*, both *Mentha* species, *Ranunculus undosus*, *Sticherus tener* and both *Viola* species.

As more new Australian plants are brought into cultivation, I suspect that those which are suited to wet soils will reach well over a thousand. In this article I have left many less commonly grown plants out, particularly those from the tropics which will not grow outdoors for me here (the Otways at 250 m in southern Victoria). Even so, it is obvious that there is nothing restrictive about the choice of plants suitable for wet soils — if anything, you will probably find it hard to choose from among so many! ■

Water and Wetland Plants For Southern Australia

by Nick Romanowski

As the principal author of this issue there is no need for me to expand on the competence and dedication of Nick Romanowski, or is there! He has a nursery, Dragonfly Aquatics, that is not open for retail trade but will supply all plants by mail order — RMB AB366, Colac 3250. Wholesale lists are available for revegetation projects and plants can be propagated to order. A mail order retail catalogue is available, send two 45¢ stamps. He has produced a book under the above title, another Lothian Books publication, widely available for \$24.95. The sections on making ponds and dams, their planning and construction, fish, water birds and other animals are very practical and invaluable if you have or want a pond or dam. The sections on plants and planting are exceptional in a practical way and based upon years of hands-on experience; the very best reference available. — Editor. ■

Plants for Wet Situations

There are often difficult spots in a garden where the soil appears to be always damp. This article is to assist you. Damp positions where nothing appears to grow are often in deep shade from the house, a fence or a tree. Shady Gardens is an article in Vol. 15:239,245 and could assist you, especially if a tree is the problem. Another alternative is to grow plants that suck up the water turning a dank place into a moist garden for plant growth. Plants in the Myrtaceae family are often suitable, especially if there is sufficient sunlight but these can grow quite large. Try *Callistemon* (Bottlebrush), *Melaleuca* (Paper bark) or *Leptospermum* (Tea tree). — Editor. ■



△ *Isotoma fluviatilis*

Photography by N. Romanowski

▽ *Ranunculus inundatus*





Top Left: A deep blackwater pool, heavily shaded, hence only ferns *Dicksonia antarctica* and *Nephrolepis cordifolia*.

Top Right: A dam with *Gahnia sieberiana* in the foreground, *Baumea articulata*, *Marsilea mutica* and *Nymphoides montana* floating.

▽ *Nymphoides indica* in flower with *Azolla pinnata*.

All photography by N. Romanowski



Thryptomene calycina

Horticultural Development of the Victorian Laceflower

by D. V. Beardsell, Institute for Horticultural Development, Private Bag 15, South Eastern Mail Centre, Victoria 3176.

Thryptomene calycina is one of approximately 35 species in a genus that is represented in most parts of Australia. It only occurs naturally in the Grampians (Gariwerd) and Black Ranges in western Victoria, and is locally known as Grampians *Thryptomene*. This name is no longer relevant, and it is now known as "Victorian Laceflower". It was discovered at Mt Arapiles in 1836 by the early Australian explorer Major Thomas Mitchell who wrote of it in glowing terms as follows "we found a fine new species of *Baeckea*, forming a handsome evergreen bush, the ends of whose graceful branches were closely covered with small white delicate flowers".

Thryptomene calycina is an important winter cut flower crop in Victoria, and export is increasing interstate and overseas. It is also grown as a cut flower crop in California. Although a delightful landscape plant, it is not hardy due to sensitivity to the root rotting pathogen *Phytophthora cinnamomi*. It can however, be readily grafted on to the more adaptable *Thryptomene saxicola*. A small cottage industry operated by the Winfield and Edwards families living near its natural range has produced flowering stems for the winter flower markets in Australia since the 1930s, and others have followed.

Harvesting is usually done with secateurs and stems are tied into bunches of 10 for storage and transport. Limited post-harvest handling treatments are used, but the flowering stems have a shelf life of up to 10 days at 20°C if the stems are quickly placed in a cool store in buckets containing a flower preserving solution or covered with moistened hessian covers. It is used as a filler in the preparation of mixed bunches.

Flowering of *T. calycina* is induced by long days in summer, and the flowers continue to develop in the cooler weather of autumn. The first flowers open in May in most years, and flowering continues until early spring. Late and early varieties will extend this flowering season. Flowering stems are harvested from field plantations throughout winter and early spring.

A selection and breeding programme was started in 1982 at the Institute to develop a series of cultivars which had very dense flowering, a range of flowering times and long vase lives, see photographs on page 168. In addition, mutant plants and selections which had pink flowers and white flowers were selected. The first two varieties to be commercially released are 'Coral Lace' and 'Ivory Lace'. Another cultivar, 'Talbot Star' has been selected by Gwen and Ben Edwards. Dwarf and weeping cultivars suitable for pot plant and hanging basket production have also been selected such as the lovely weeping cultivar 'Cascading Lace'. All are available from Kurunga Nursery, 393 Maroondah Highway, Ringwood, Victoria.

Flowers can be damaged by severe frosts (below -3°C). A number of pests and diseases have been found on *T. calycina*. Thrips feed on the nectar and pollen produced by the flowers, webbing caterpillars feed on the foliage and borers can ring-bark stems. Tip dieback of branches also occurs from an interaction of the pathogens *Botrytis* sp., *Pestalotia* sp. and *Phoma* sp. This can be controlled by application of Mancozeb®. ■

Grafting Trial 1 — Grafting of *Thryptomene* cultivars on to potted rootstocks

Wedge or whip grafts were used to graft either *Thryptomene calycina* 'Winter Snow' or *T. calycina* 'Black Range Pink' (cultivars developed at the Institute of Plant Sciences) scion wood on to rootstocks of *Thryptomene saxicola* 'Payne's Hybrid', a form of the species that has proven hardy. Clonal rootstocks of *T. saxicola* were placed as cuttings in February 1988 and potted on as rooted cuttings in April 1988. They were then grown on in a glasshouse until grafting in November, nine months after the cuttings were first taken. At the time of grafting the leaves of the tip of the selected branchlet of the rootstock were removed for about 30 to 40 mm leaving the leaves at the basal end intact to provide nutrition for the rootstock and to assist the formation of a successful graft union.

For wedge grafting the selected branchlet was then cut down its centre for a length of about 20 mm to receive the scion. For whip grafting a sloping cut was made starting about 20 mm in from the end of the branchlet.

Scion wood was taken from plants which were actively growing in pots in a glasshouse at the time of grafting (January). The scion was prepared in a similar manner to a cutting, with the terminal shoot removed leaving several short lateral shoots at the tip of the scion, while the basal two-thirds was stripped of all leaves. Scions were on average 500 mm long and 2 mm thick. For whip grafting a sloping cut was made on the scions which matched the cut in the rootstock. In wedge grafting the basal end was then cut to a "V" shape which was inserted into the cut made into the tip of the selected rootstock branchlet.

The graft unions were wrapped firmly with plastic grafting tape, and each scion was covered with a clear plastic bag for four weeks after grafting. The grafted plants were grown on in a glasshouse and the plastic tapes were cut three months after commencement of the trial.

Results — Graft unions were assessed four months after grafting and were regarded as successful if callus had formed and the scion was actively growing at this stage. Both cultivars were successfully grafted, with means (of wedge and whip grafts) of 68% of cultivar 'Winter Snow' and 77% of cultivar 'Black Range Pink' forming graft unions (Table 1). Overall the wedge type of graft proved to be the most efficient with a mean success rate of 86% compared with 60% of whip grafts forming unions. A grafted plant with scion actively growing is produced in six months. The grafted plants have been grown on for five years and the growth of both scion cultivars has been normal. The scions have grown between 40 to 80 cm in their first year. These are being evaluated in a cut flower plantation.

Type of Graft	Per cent grafts taken	
	'Winter Snow'	'Black Range Pink'
Wedge	100	71
Whip	36	83
Mean success	68	77



△ *Thryptomene calycina*,
the Victorian Laceflower as found in the wild.

▽ *Thryptomene calycina*,
'Coral Lace', a selected form.

Photography by D. Beardsell





△ *Thryptomene calycina*, 'Ivory Lace',
a selected form.

▽ *Thryptomene calycina*, 'Talbot Star'

Photography by D. Beardsell



Grafting Trial 2 — Grafting of *Thryptomene* cultivars on both potted rootstock and as Cutting Grafts

Five different cultivars of *Thryptomene calycina* (as listed in Table 2) were grafted on to *T. saxicola* 'Payne's Hybrid' rootstocks using either wedge grafting — Trial 1, or the cutting-graft technique as described below. The *T. calycina* 'Coral Lace' and *T. calycina* 'Sunset Lace' scions were from older plants with hardened growth while *T. calycina* 'Winter Lace', *T. calycina* 'Ivory Lace' and *T. calycina* 'Cascading Lace' were from plants with softer growth.

A. Wedge Grafts

Rootstocks used for wedge grafting were six months old (from initial placement of cuttings) and were actively growing in 150 mm pots when they were grafted in January 1990. Branches of suitable size (about 2 mm thick) were selected, and the leaves at the tip end were removed for about 30–40 mm.

The scion was taken from containerised, actively-growing plants. The terminal growth was removed leaving two shortened lateral shoots at the tip end while the basal two-thirds was stripped of all leaves. The wedge graft was done in the usual manner by cutting the scion so as to produce a "V" shape 10–20 mm long at the basal end which was inserted into the cut tip end of the rootstock. The union was then firmly tied with plastic budding tape. The wedge grafts were made as low down on the rootstock as possible. The grafted shoots were staked upright and enclosed for about two weeks with an open plastic bag supported over the scion. This created a humid micro-environment for the scion and graft union. Several other branches were initially left on the rootstock, but reduced to a maximum length of 100 mm. These were to provide nutrition for the rootstock and to assist the formation of a successful graft union.

The plastic tapes were cut eight weeks after grafting and branchlets other than the grafted ones were removed from the rootstock at this stage. Seven replicate grafts were made for each cultivar.

B. Cutting Grafts

Rootstocks for the cutting grafts were taken from actively growing plants in pots of *T. saxicola* 'Payne's Hybrid' in early summer (January) and early autumn (March). Shoots about 2 mm thick were selected and cut to lengths about 80–100 mm long. A pair of lateral branchlets were left about half way along each of these and they were both reduced to about 25 mm in length. it was anticipated that the rootstock would produce roots more readily if these branchlets were retained to provide photosynthates. The proximal end of the rootstock was then stripped of all leaves and was grafted, using a wedge graft, with one of the five different scion varieties. Fourteen replicated grafts were performed for each cultivar.

The scion was prepared and the graft made in the same manner as described in Trial 1 for the wedge graft technique. The cutting graft was then treated like a standard cutting. The basal end of the rootstock was dipped in the root promoting gel, Blue Clonex (3000 ppm IBA), and was then placed in propagation mix in individual pots, which were placed under intermittent mist with bottom heat (25°C). The mist bed was located in a glasshouse and kept lightly shaded until roots formed. The temperature regime in the glasshouse was 15–27°C.

The grafts were assessed four months after grafting and were considered to be successful if adequate callus had formed over the graft union and if the scion was actively growing. Some cultivars showed active growth within about one month from grafting, however, to ensure complete union, the grafting tapes were not removed until two months after grafting.

Table 2 Cultivar	Successful Grafts (%)	% Successful Cutting Grafts	
	on to rootstock — Trial 2	Early Summer	Early Autumn
'Coral Lace'	42	71	14
'Sunset Lace'	71	78	57
'Winter Lace'	14	35	14
'Ivory Lace'	14	71	64
'Cascading Lace'	85	64	78

For Wedge Grafts the success rate varied considerably depending on which cultivar was used as scion material. There was no obvious reason for the variation but the low success rate with two out of three of the cultivars which had "softer" scion material may indicate that this material is more subject to desiccation prior to graft formation than "harder" scion material.

For Cutting Grafts

The formation of roots on the rootstock was rapid with most forming a viable root system within four weeks of placement in the mist bed. The cutting-grafts were potted up at this stage and hardened-off under shade for a further week. Scion growth also occurred rapidly, with many showing active growth by the potting stage. The plastic tapes were removed three weeks later (eight weeks after initial grafting). The plants were assessed four weeks after the tapes were cut.

The results from this trial suggest that cutting graft production of *T. calycina* cultivars is feasible. The success rate for *T. calycina* 'Winter Lace' and 'Coral Lace', was low in late summer. *Thryptomene calycina* 'Winter Lace', a large-flowered tetraploid cultivar, has proven difficult to graft successfully by either standard wedge grafting or cutting grafting. The success rate of the other three cultivars was acceptable. The cutting graft method significantly reduced the time taken to produce actively growing grafted plants from about nine months, in the case of standard wedge grafts, to about two months. This is due to the reduced time taken to produce rootstocks large enough for successful grafting when standard wedge grafts are done and the more rapid formation of graft unions. The nursery space required using the cutting graft technique is also reduced because of the reduced unit size of a cutting-graft compared to handling rootstocks in 150 mm containers.

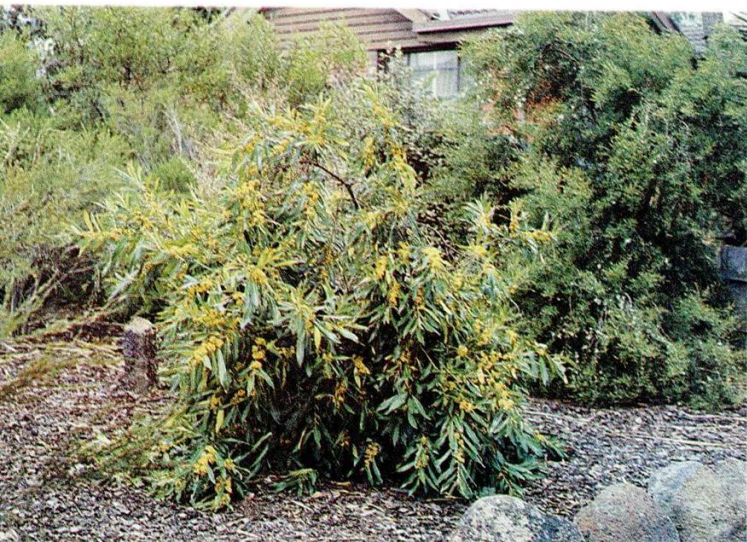
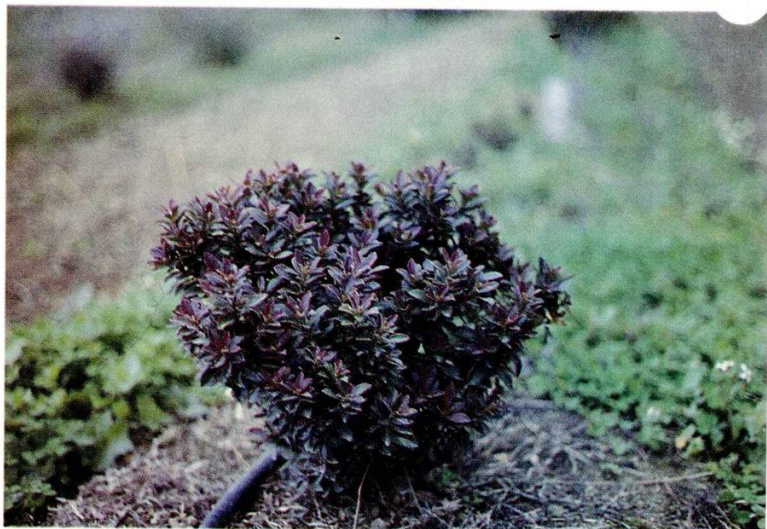
Acknowledgments — Michelle Bankier looked after the plants in these trials. Tony Slater provided assistance with photography, and Rodney Jones and Gary O'Connor corrected the manuscript. This programme was funded by the Department of Agriculture, Victoria and Daratech Pty Ltd. ■

Wildflowers for Horticulture — The only way we can confidently purchase the best forms of plants from the wild is for selections to be marketed under a cultivar name. These plants may be obtained from Kuranga Nursery, 393 Maroondah Highway, Ringwood, Victoria 3134. — Editor.



◁ *Tristaniopsis laurina*
 'Golden Summers'
 Photographs by
 D. Beardsell

Tristaniopsis laurina ▷
 'Purple Haze'



▷ *Tristaniopsis laurina*
 'Fiona Matthews'

Tristaniopsis laurina

HORTICULTURAL DEVELOPMENT

by David Beardsell and Ulla Tingsgaard¹
Institute for Horticultural Development

*Tristaniopsis laurina*² is a medium sized tree which grows to 15 m and occurs in riparian habitats along rivers and creeks from the Avon and Bemm Rivers in eastern Victoria to rivers in south Queensland. Along these rivers many magnificent old specimens covered in epiphytic plants can be found. It does not vary greatly in the wild, although smooth and fibrous barked populations are known.

Tristaniopsis laurina is an attractive and useful shade tree for parks and gardens. It has been used as a street tree in the eastern suburbs of Melbourne, but it has been slow growing in areas of less than 30" (800 mm) rainfall. It is also resistant to waterlogging (Beardsell 1981) and can be used in stream bank revegetation programmes. Several beautiful, 60 year old specimens are in the Royal Botanic Gardens, Melbourne. No cultivars are currently available as *T. laurina* is generally propagated by seed. Unlike the related *Lophostemon confertus*, *T. laurina* can be readily propagated from mature trees by cuttings or grafting (Beardsell 1982). This encouraged us to develop foliage variants by raising large numbers of seedlings.

Seed was collected from 8–12 year old, open pollinated *T. laurina* trees growing in street plantations in Boronia and Blackburn, Vic., in July 1981 by shaking branches over plastic sheets. This allowed easy collection of large amounts of seed. Approximately 400,000 seedlings were raised in a glass-house in large polystyrene boxes. Cotyledons and first true leaf pairs were examined closely as they germinated and grew, and any showing abnormalities such as lines, sectors or spots of different coloured tissue were picked out and potted on. Plants with white, golden, purple and mosaic sectors were selected. Careful tip pruning was done to develop the sectors or mosaic patterns into leaves that were completely variegated or which had variegations on part of the leaf.

Approximately one per thousand seedlings of *T. laurina* showed some abnormality; the most common being albino, golden and purple sectors and golden mosaic stripes. The high frequency of the chlorophyll-deficient mutants is probably due to the large number of genes involved in chlorophyll synthesis.

The following cultivars were selected. They are available from Kuranga Nursery, 393 Maroondah Highway, Ringwood, Victoria.

Tristaniopsis laurina 'Golden Summers'

This cultivar is a green/white/green chimera (Beardsell and Considine 1987) which has leaves with golden yellow margins. New growth has reddish flushes. This lovely plant is less vigorous than wild green plants of *T. laurina* and should be an ideal garden plant suitable for planting as an alternative to *Pittosporum eugenioides* 'Variegata'. The golden margins of the leaves are complemented with the golden flowers which appear in January–February. This cultivar is the best of the seedlings with variegated leaf margins.

¹David Moore and Mark Annandale helped scan seedlings and maintained the plants after selection. This project was funded by the Department of Food and Agriculture (Victoria) and the University of Georgia. Tony Slater and Gary O'Connor revised the manuscript.

²It was formerly known as *Tristania laurina*, but Wilson and Waterhouse in their review of *Tristania* and related genera placed it in the genus *Tristaniopsis* (*Australian Plants* Vol. 12: 262).

***Tristaniopsis laurina* 'Purple Haze'**

This cultivar is a dwarf form with dark purple leaves. The purple colour is sometimes a mosaic with green sectors. The plant has leaves approximately a third normal size and it lacks apical dominance thus forming a multi-branched small shrub. Five year old plants are yet to flower and are approximately 1 m high (a third of the height of wild types). Since leaf sections showed that enhanced anthocyanin was only distributed in tissue of the hypodermal layers of the leaf, it is possible that a very dark purple-leaved cultivar could eventually be derived from this attractive cultivar by substitution of the green central parts of the leaf with additional purple coloured tissue.

***Tristaniopsis laurina* 'Fiona Matthews'**

This cultivar has pendulous branches and a semi-dwarfing habit. Leaves and flowers are similar to wild types and the bark is distinctly mottled. New growth has a brownish tinge. Flowering is precocious, occurring as early as one year after cuttings are struck. This cultivar could be used as a landscape plant for use near water features such as ponds; an excellent substitute for *Salix babylonica* (Weeping Willow) with the advantage of being much less vigorous.

An Automatic Misting Controller For Your Cuttings

There are probably many misting controllers available, though most seem to be designed to suit the large commercial installations. I have had a very simple, fool-proof misting controller operating in my propagation house for a number of years now and it has been ideal. I have left it operating automatically for years and leave it for days without even checking up on its performance. I go away for weeks, even months at a time without concern. Of course, when away more than a few days, a neighbour checks on it but over the years she has never had to do anything. At the expense of favouring one manufacturer I feel I must share my good fortune.

Called a Watermatic Misting Controller Kit marketed by Watermatic Controls Pty. Ltd. it comprises a small controller, one or more 24 volt solenoid valves and plastic tubing to which the misting spray heads are easily fitted to suit your installation. What attracted me to it in the first place is that the power-pack which is plugged into an ordinary mains 240 power point, may be placed quite a long way from the propagation shed, in a position well out of harms way. The two leads to the propagation shed only carry electricity supply at 24 volts and can safely be suspended for some distance from tree to tree to shed. Any inquisitive person entering the propagation shed is completely safe from electrocution.

And it works! There are two dials, one for the duration between misting over the cuttings and one for the length of time you want misting done. Mine has been set for the last year at 4 seconds of spray every 20 minutes. There is a sensing light that automatically increases the time period between misting by four times; in my case during the night it mists for 4 seconds every 80 minutes. The only trouble has been from the 24 volt solenoid valve that appears to seize up and requires replacement at about 2 year intervals. It is a cheap plastic model and I suspect just as reliable as the more expensive brass units. The whole unit is easily installed.

The complete kit appears to be widely available but if you have trouble telephone Controlled Sprinkler Supplies, 16 Kim Close, Bulleen 3105 on (03) 850 9466 — Editor. ■

Grafting The Forest She-oak

by David Meyers, David Beardsell and Ray Kerr,¹ Institute for Horticultural Development², Private Bag 15, South Eastern Mail Centre, Victoria 3176.

Allocasuarina torulosa (syn. *Casuarina torulosa*), the Forest She-oak, occurs naturally in Queensland and New South Wales and is widely planted in other areas as a feature tree or street tree. It is dioecious, having separate male and female trees. Female plants produce attractive hairy, yellowish flowers and cone-type fruits, and male plants produce orange spikes of flowers near the tips of branchlets.

Some individuals of this species produce a deep, burgundy-coloured foliage which is regarded as having superior ornamental merit to the more common brownish-green foliage, other specimens have attractive corky bark and others have a weeping habit.

Propagation from seed, which is the common propagation method for this plant, results in considerable variation in foliage colour, canopy shape and bark appearance. Seed propagation also allows no control over the sex of the plants produced.

Horticultural development of this species firstly requires selection of superior clones from the wild and from plantations. Secondly, a method of vegetative propagation is needed to produce elite cultivars of this plant.

Two outstanding plants of this species, selected by the senior author, have pendulous burgundy foliage and attractive corky bark. These can be propagated by grafting as described in *Australian Plants* Vol. 17, page 77. One is male and the other female.

***Allocasuarina torulosa* 'Horsetail'** — A male plant with weeping branchlets 10–40 cm long, foliage burgundy, male flowers reddish-orange and appearing in July, bark cream-brown and corky. Plant obviously does not produce fruits.

***Allocasuarina torulosa* 'Fiona Matthews'** — A female plant with weeping branchlets 10–50 cm long, foliage burgundy-green, female flowers cream and appearing in June, fruits egg-shaped 2.5–4 cm in size, bark cream-brown and corky. A more vigorous and dense crown than cv. 'Horsetail'. A more pendulous habit than cv. 'Horsetail'.

Successfully grafted plants have been grown on for five years and all have made vigorous growth with no signs of graft failure or incompatibility. These will be evaluated over the long term in a field plantation at the Institute for Horticultural Development. Scion wood of these cultivars is available from David Beardsell, Institute for Horticultural Development as above. ■

¹Michelle Bankier maintained the plants in this trial. Tony Allen and Gary O'Connor revised the manuscript. This project was partly funded by Daratech Pty Ltd.

²This work by **The Institute for Horticultural Development** is to be widely applauded. Their resources are devoted to assisting the commercial horticultural industry, both at the nursery level and the commercial cropping of cut flowers. While the two trees mentioned above and opposite are ideal for landscaping projects to beautify our vistas, they also show a deep concern for the environment and the future of this planet. From time to time we hear of grand plans by government departments but these are rarely translated to the consumer, John Citizen. If ever these grand plans come to fruition, is the product really commercially viable and where do we purchase plants? In this case the Institute for Horticultural Development has not only developed excellent selections from wild populations, but they advise where these plants can be obtained, Kuranga Nursery, 393 Maroondah Highway, Ringwood, Victoria, and are even prepared to supply plant material for grafting on request — Editor.

Wildflower Gardening

The Best Use of Natural Water

by W. H. Payne

Wildflowers are like any other plant, they need nutrition, sunlight and **fresh water** in a situation that suits them. Our situation is in the garden whether the plant likes it or not. Strange as it may seem, the plant may prefer the garden to "conditions in the jungle" provided it gets nutrition, sunlight and **fresh water**. Our wildflowers have developed over ages to thrive in low nutrition situations so let us forget nutrition for the moment. This leaves us with sunlight and **fresh water** and, provided you have been realistic and planted shade loving plants in the shade, any open aspect in the garden will suit all the rest, provided you have supplied the one vital ingredient left — **fresh water**.

By fresh water, I mean fresh water in the ground that the roots can reach, not fresh water above ground on the foliage, or fresh water at ground level, both of which may be refreshing if applied correctly but both of which may preferably be done without provided the below ground water is sufficient, available and **fresh**.

I have seen hundreds of gardens over the last 33 years while I have edited Australian Plants, and the successful ones have all had one thing in common, fresh water freely available at a depth below ground level. Most successful gardeners have happily achieved this situation in ignorance, basking in the compliments from envious admirers. An increasing number of successful gardeners have achieved a wildflower spectacular after careful thought and planning directed towards the supply of **fresh water** below ground.

What are the ideal circumstances for **using this fresh water** and what is meant by fresh? The ideal wildflower garden is on a gentle slope facing north, the garden terraced to suit the slope with a natural water table one metre or more below ground level, and a continuous supply of water slowly moving down the sloping water table. Never stopping, it slowly moves downhill being filtered beautifully fresh and sweet as it passes from one open soil space/particle to the next. The plants roots will go down to this water table and healthily suck up moisture and nutrition, showing their pleasure with healthy growth and bountiful flowering.

What is this **water table**? In the sense I have used the term, it is certainly not flat and level like a table but rather an inclined plane or a table with the legs on one side a little shorter than those on the opposite side providing a small slope. Things will roll down it and certainly water will slowly trickle from the upper side to the lower side. Below the ground there are layers of various types of earth. The upper crust has been formed over the years by composting matter in grainy soils and will naturally hold air and water suspended between the soil particles. These particles do not fit snugly together but in healthy soil have air spaces between them. Below this surface crust is usually a layer of heavier earth with the particles more closely bound together such as the clays. The surface where this largely water-impervious, clay-like material meets the upper crust is what I call the water table.

Fresh water underground? When rain falls the surface crust absorbs water which gradually seeps down until it meets the water table. Being unable to penetrate the lower clay-like material as quickly, it forms an underground

sheet of water (or wide shallow river) that moves down the water table, always filtering down to the lowest level of the slope. This is done quite slowly, but its filtering movement between soil particles makes it fresh or "sweet" to plants. When it reaches the bottom of the slope it accumulates and goes stagnant forming a bog or swamp.

The upper crust of soil need not be sandy. In fact a heavier uppercrust soil is usually the best soil for growing plants. It holds the nutrients which are often washed out of sandy soil. A water table may still exist below it where it meets a layer of more impervious "water proof" soil and provided you have the slope and a continuous supply of water, your garden will be quite spectacular.

The objective now is to maximise whatever natural features you already have in the way of sloping land and soil and if none, then to create these conditions artificially as described below. A continuous supply of water! You will be surprised how much nature provides if you use it carefully. If you are unfortunate enough to live on top of a dry sandy ridge, as I do, where there is no natural water movement from rain runoff on higher ground, then you are in trouble as well as having a high water bill. Even here there is much that you can do and after all, it is nice to live on top of a ridge and overlook scenery or lower mortals below you.

The Missing Element

To simplify the story I have left out a vital ingredient — **AIR**. Practically all living matter needs it in one form or another. We need the Oxygen in air to survive, exhausting Carbon Dioxide. Fortunately, plant life needs Carbon Dioxide, exhausting fresh Oxygen for us, and Nitrogen. The Nitrogen cycle is a complex one that we shall examine in a later issue but, at this stage, it is sufficient to realise that plants need air in the soil as well as around their leaves above ground. The capacity of the soil to retain air and moisture in the spaces between the soil particles is vital. Enough of this later, let us stick to the water problem.

To Maximise Your Natural Water Supply

One of the finest gardens I have seen is that of John Hunt who lives on top of a dry sandstone ridge at Castle Hill, north-west of Sydney. He has a passionate view concerning natural water. Every litre of natural rainwater that falls on his property is channelled to trenches in his garden. In fact, his whole garden is built upon a network of trenches first channelled out of the impervious clay gravel under soil, often through soil rock, to get a very slight fall. Most of these are covered and raised gardens built on top or beside them. Some of these trenches appear as sunken pathways or natural water courses between the garden beds. This device seems to transform a flat featureless site into an interesting network of inviting mystery as well as performing a real purpose of water conservation.

For a gently sloping site the trenches or water paths will zig-zag across the block to slow down the water and encourage it to soak down to the water table. With all these water control schemes, there is provision for overflow in a heavy downpour.

Water Retention on Significant Slopes

If your garden has a section with a significant slope, say down a dry sandstone ridge as mine does, you have a problem that I have solved as follows. Such a rocky slope is almost impossible to water without this simple practice. Left alone you will find that leaf litter will fill the crevices between rocks and even cover flat rock surfaces. It will pile up against the rocks providing a water shed that seems to stop the entry of water, sending all rainwater shooting over the surface, down the slope to be lost. It seems to encourage the growth of weeds such as Privet, *Pittosporum*, Wandering Jew, Mother-of-millions, etc. which in turn adds to the litter on top of rocks and smothers the native plants.

The solution is simple. Remove all litter from the top of rocks exposing them to display their beauty on the slope. This greatly reduces the area in which weeds can grow. If possible, lever the rocks out such that there is a space behind them and the biggest face is closer to vertical. Arrange the soil and litter between the rocks such that it slopes back down into the hillside. The rain will then cascade down the upper rocks but be trapped between the rocks below and go into the soil where much of it will be retained.

With time you will find that the leaf litter will again tend to build up to defeat this scheme, so once a year pull the leaf litter away from the inner rock and restore an inward facing slope. On this annual tidy-up you must also remove litter accumulated on top of rocks to prevent weed growth. Now you have a natural looking rock garden that requires very little maintenance and no watering. If you plant some wildflowers in the crevices, they will only need extra water very infrequently over an extremely dry period.

Successful Wildflower Gardens

Having read the above, think back to all the good wildflower gardens you have seen or read about in *Australian Plants*. All have ideal water control. What good is a built-up sand garden unless it is sitting on a damp bed of clay with continuous fresh moisture. Try building a built-up sand garden on very deep dry sand and see the weak plants supported by a huge water bill. But, if it is built on dry sand that has a fresh water table a metre or more below the surface, the result is spectacular, the roots will go down to the water.

There are many plants with surface feeding roots. The capillary action of coarse grained sand does suck up the water moisture but a cool root run is also necessary, even those that are found in what appears to be desert conditions. The importance of mulching to conserve surface moisture is evident. How this mulch is provided is critical. The secret to Michael Filby's garden (Vol. 17:47) is that he first covered his heavy soil flat area with gravel to accommodate the collection of water, then covered this with a deep litter mulch and covered this again with a gravel mulch. The surface between the two gravel layers is rich in nutrition, fed with moisture from below but protected from the sun above by the layer of gravel. A vulnerable point for most plants appears to be where the stem/trunk emerges from the surface layer of soil. If this surface layer is a mulch of warm decomposing litter, harmful pathogens appear to flourish, destroying the outer covering of stems and roots. A covering of gravel or coarse sand conserves moisture and reduces the ability of these pathogens to prosper. ■

Hydroponic Gardening

The More Direct Use Of Water — Editor

Hydroponics is said to be the growing of plants without soil. It is really the cultivation of plants in a container containing some medium for holding the plants upright and for their roots to grow in while controlling the amount of water and nutrients that are introduced to these roots. The first development of the system is the cultivation of specimen plants in pots. We decide what the potting medium will be and what is the best way to water it and feed it for best results.

Hydroponic gardening is usually associated with the commercial culture of plants for flower cropping or vegetable production but the systems use could well be applied to ornamental pot culture, especially for flowering pots that may be brought into the living area when in full bloom or the most attractive period of leaf presentation. Many are already using the simple "wick" system where the plant container sits in another container of water with some device for the water to travel up a "wick" of some sort to maintain the moisture level around the plant roots. ■

Container Gardening

The Best Way To Water — Editor

We propose to devote a lot of study and research to the more effective cultivation of wildflowers in pots, especially to decorate the home. Will readers with some experience with successful pot culture or any form of hydroponics please contact the Editor, *Australian Plants*. For those keen to experiment themselves they may find the following book of great assistance.

Hydroponics Gardening by Steven Carruthers, a book in the Lothian Australian Garden Series, widely available at booksellers for \$12.95. ■

Water In Your Garden

by Paul Thompson*

This book will provide inspiration and information that will stimulate novel approaches to the use of water in the garden. The information is aimed at home owners keen to instal some water element in the garden. This can best be done professionally but owners would be well advised to study features in the book so as to be able to contribute to discussions as to what best suits you and your home. For those who wish to construct the water feature themselves, the step by step advice in the book will be invaluable.

Ponds and pools, their construction with various materials, waterfalls, creeks, bridges, fountains, lighting, ground surfacing, water pumping and planting are features described and illustrated with sketches.

Our gardens are to give pleasure and increase the quality of our life style. Paul Thompson clearly appreciates this and the peace that some water feature can bring to our home environment. Landscapes must be non-demanding of water, yet satisfying to the occupants. He places the conservation of water and its most effective use as a first priority and this is his chapter one. The practices recommended in this issue of *Australian Plants* are again stressed, with much thought given to retaining any run-off that cannot be absorbed by such water conservation practices.

*Paul Thompson has been designing and building gardens for 20 years, his creations receiving acclaim and awards. He is author of the book "Water In Your Garden" and clearly this is a review. It is not possible in the space available, to present all aspects of the use of water by the home gardener and I am pleased to refer readers who wish to know more about water features to the professional advice given in the book. It will be widely available as one of the Lothian Australian Garden Series for \$12.95 from your bookseller. ■

Karwarra Australian Plant Garden

by Marilyn Gray

Tucked away in the Dandenong Ranges at Kalorama, not far out of Melbourne along the Maroondah Highway (take the Mt Dandenong Tourist Road and travel 6 km out of Montrose) is a well cared for Australian garden. To the credit of the Shire of Lillydale and the Mt Dandenong Horticultural Society, this magnificent garden is available for public inspection on Wednesday to Friday, 11 a.m. to 4 p.m., and Sunday 2 p.m. to 5 p.m. Started in 1968, it is well established with the benefits of numerous competent landscapers and experienced wildflower horticulturists. Being an old, well established garden, it has gone through phases of excessive growth and shade in some areas with very pleasant, even spectacular presentation in others. If you saw it years ago, go again, you will be impressed with the difference.

This beautiful wildflower garden will be a feature of a future issue of *Australian Plants*, as there is much to be learnt from the practical experiment in landscaping using Australian wildflowers. It is just chance that this issue desperately needs illustrating with successful water features and Marilyn Gray came to my rescue. Her enthusiasm and competence is reflected in the current spectacle at the garden. There have been many competent horticulturists involved, more recent ones being Rodger Elliott and the Curator until recently, John Knight. John describes how he created the three most recent pools pictured opposite. Some of the plantings in these pools include a bold experiment with low growing Tasmanian plants so we can look forward to an interesting report in the future — Editor.

Building the New Pools at Karwarra Australian Plant Garden

by John Knight

The pools resulted from the need to find a source of soil to complete a raised garden bed. To avoid importing soil and more weeds, and possibly soil pathogens, it was decided to incorporate pools adjacent to the garden. The first pond is 50–150 mm deep and measures 1.5 × 2 m. The larger central pond, 6 m long, varies from 150 mm to 500 mm deep with two platforms to accommodate plants in pots. The last pond, 2.5 m long, has a depth of 600 mm, with steep sides.

The ponds are sited on a gentle slope, each connected by a narrow channel to allow water to flow through each. Water is reticulated by a submersible sump pump with an output of about 1 000 litres/hr with a head of 7 m. The scheme includes a man-made creek, another feature of the garden. The flow is sufficient to provide a perception of flow over rocks at the top pond with a pleasing sound of water falling across the rocks and a ripple effect across each pond.

The soil excavation was covered with 50 mm of sand (builder's fatty sand to hold its shape). This was covered with heavy-duty plastic sheeting which extended 200 mm past the edge of the ponds and was taken under rocks so that water could lap the rocks which formed a boundary of the pools.

The mix comprised 1 part lime, 2 parts cement, 2 parts sand and 6 parts mountain soil. It was used just moist as the soil imparts a plasticene effect which is lost if worked too wet. The mix was thrown on to the plastic sheeting, thus eliminating air pockets and save having to stand on the plastic. When sufficient mix was placed on the plastic it was worked, from the base up the sides, smoothing by hand using wetted plastic gloves.



△ A pool at Karwarra Gardens featuring *Utricularia gibba* (yellow) and *Marsilea drummondii*. Photograph by Kath Deery.

▽ The new pools at Karawarra Gardens built and photographed by John Knight.



As each section was completed, to ensure it dried slowly, it was covered with newspaper which was held in place with mulch, and wetted down and kept wet for a week. Minor adjustment was required to establish level sides all around. After preparing another batch of mix, the surface was scratched on the edges to provide a key, wetted and completed as required.

Whilst not as strong as concrete, the mix is solid and hard, can be walked on without breaking and, importantly, because of the soil content, the colour blends in and roots attach to the surface but do not penetrate.

Water — When and How

by W. H. Payne

We all want to artificially water our plants as little as possible. Max Hewett, in Sydney, for instance, believes we should not water and has spent years studying the effects of non-watering which of course includes dead plants. After his plants have become established, he does not water. His plants go through a period of dry weather where they may look less lush, or even positively sick, but when rain comes they restore their presentation and flower bounteously.

However, Max does all the correct things as recommended in this issue. The plants include many that no others can grow successfully, *Verticordia* for instance, plants that have adapted over generations to survive extended dry conditions over summer. His garden is built up such that there is adequate depth of well-drained soil with "ditches" (paths is a kinder word) to retain any rain that does fall and direct it to the deeply exploring plant roots. He mulches the surface of the garden with coarse gravel to retain whatever moisture there is in the upper soil layer and to keep the surface roots cool.

To be fair to Max he does nurture juvenile plants. Quoting from his article in Volume 11, page 371 — "Summer watering is applied individually to juvenile plants by allowing a hose to drip very slowly, or by provision of a container with a nail hole in the bottom. Such watering is only applied when absolutely necessary to ensure survival, and not in sufficient quantity to influence any adjacent mature specimens. It is to be applied at night and preferably when cooler weather prevails. Winter watering of the entire garden by general sprinkler, or by prolonged use of the hose drip method is used under dry seasonal conditions when necessary to restore soil moisture, or in early spring, to provide a boost to pre-flowering growth."

To appreciate just how to grow gardens with a minimum of water refer to his article in Volume 11, page 371. The theory applies not only to *Verticordia* which are the object of his primary study but to the more difficult and seemingly delicate plants such as *Boronia*.

Another excellent garden in Sydney that is a spectacle but receives nothing but nature's rain except in extreme conditions is that of John Hunt, mentioned in my article on page 177, a magnificent garden, for the reasons given. I can sense the mutterings, it is alright for Sydney but what about my conditions here. Hopefully, all the answers are in the articles here and in reports from other growers from your area as published in previous issues.

But! I water my garden, tongue-in-cheek while handing out advice? My problem is that I am on top of a dry sandstone ridge without water seeping down from land above me, and I am in an apparent "rain shadow". The showers seem to part and pass us by, raining on all sides. The real problem, however, is trees, beautiful majestic trees, but, if you refer to page 154, very efficient water pumps. Each has its 100+ km of root reaching into any soil space with moisture, pumping the precious soil water up to the leaves and releasing it to the atmosphere to make more rain. In addition, the leafy canopy intercepts much of the rain before it reaches the ground and more importantly it reduces the amount of sunshine at ground level. For many plants it is a choice between a colourful garden or the trees. I want both and we are happy to pay for it in the form of water.

You cannot have a dense stand of trees and a flourishing garden without a very severe restriction on the type of plants grown. We have a natural wooded area that has many wildflowers flourishing, shallow rooted plants in the main, that grow in forests. See my article Vol. 8:17. We also have an area near the house that has only a few trees and "formed" gardens and, because of the trees in both areas, we need to artificially water when it is dry — but no lawns.

We follow all recommended practices where possible, conserving natural water and reducing runoff, mulching the soil surface, good soakings infrequently rather than a little water often, not watering in the heat of the day, etc., but our plants (and our trees, bless them) still need water when it is dry. Thirty years ago I installed permanent watering systems with iron pipes and fixed spray heads and these are still operating well. Because of the area this needed some 20 taps to control 3–4 spray heads each but at the rate of one or two a day it has meant very little work to water the garden. The watering in the areas is consistent and soaking to the extent possible (nothing is as good as a good shower of rain) with fringe areas receiving consistently less. We have a long driveway down between the trees and set sprays either did not water the edges where we wanted small showier plants, or the set spray wasted too much water on the driveway. A modern sprinkler system of plastic piping and 180° spray heads has been very good, though you see the small spray heads standing up along the drive edge at 2-3 metre intervals; blow the appearance, we get the pleasure of our plants with a minimum of work. Near the house we resort to a set hose. ■

The Water Garden

by Anthony Archer-Wills Published by Angus & Robertson

Gardeners in Australia have become wary of books written for English conditions, without any warning being given before purchasing them, as in this case. However, this book is so well presented and illustrated with beautiful colour photographs of ponds and water features, it is worth careful study.



△ Karwarra pools with bridges and garden. Photograph by K. Deery.

▽ A private pond with *Alisma plantago-aquatica*, *Marsilea drummondii* and *Myriophyllum* sp.
Photograph by Marilyn Gray.





△ *Restio tetraphyllus* the tightly clumping reed-like plant in foreground: *Baumea rubiginosa*, slender, wire, upright stems topped with compact, rusty flower heads and the pond covered mostly with *Myriophyllum* species and *Triglochin striata*.

▷ *Brasenia schreberi* with floating leaves and small, purple, waterlily-like flowers.

▽ *Cyperus lucidus*, rosettes of sharp-edged leaves, tall flower stems of red-copper flowers.



CSIRO Handbook of Economic Plants of Australia

This book is an expanded and revised edition of William Hartley's 1979 "A Checklist of Economic Plants of Australia". Thousands of species are listed in generic order giving the scientific name and common name, its natural distribution, whether it is a herb, shrub or tree and its recorded use in other literature. It is available from the CSIRO Bookshop for \$50.

Bonsai — Art and Technique

by Jennifer Wilkinson

One huge step further to growing plants in containers is the art of growing plants stunting their growth by pruning above and below ground level. The art of appreciating the style and form of a tree reduced in size so that it may adorn a mantelpiece or table. Watering correctly is vital. Readers with some experience in this art should contact the Editor, *Australian Plants*. Others who would like to know how to start could purchase a book of the above name from your bookseller for \$12.95. It is also one of the Lothian Australian Garden Series.

Wildflower Nurseries in Queensland

Fairhill Plants and Botanic Gardens — Fairhill Rd., Yandina, 4561. Tel. (074) 46-7088. Large range of trees, shrubs, ground covers, climbers, ferns, palms and orchids for the sub-tropical and tropical east coast. Extensive display gardens open 8.30 a.m. to 5 p.m. any day. New comprehensive catalogue \$14.00 posted.

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Wildflower Nurseries in Victoria

Australfora — The nursery with the "Native Know How" — Belfast Rd., Montrose 3765. Tel. (03) 728-1222. Mon-Sat. 9-5.00 p.m. Sun. 10-5.00 p.m.

Bushland Flora — Indigenous plants of Melbourne. Ph. (03) 736 4364 for stocklist.

Kuranga Native Nursery has the largest range of Australian plants in Melbourne. Decorative flowering plants, hardy varieties, indigenous plants, grasses, etc., advanced grass trees, rainforest plants and more. Kuranga Native Nursery, 393 Maroondah Highway, Ringwood 3134. Mel. Ref. 50 B5. Tel. (03) 879 4076 — open 7 days.

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Australian Plants — Your Journal

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Hopefully, some will support me in a more direct way. We all agree that the articles on plant descriptions are valuable and much effort goes into making these as simple as possible. Without *Australian Plants* such descriptions for the non-professional would cease. It is also a policy to include as much as possible on practical advice on cultivation of our wildflowers and their propagation. For this I need your help.

Pimelea — will readers please advise what experiences they have had with cultivation and propagation.

Gardening in the North and Dry inland Areas — I need comments and advice.

"Australian Plants", The Australian Flora Periodical

Past issues are available for all volumes (4-10), each volume is bound and cased, beautifully presented with green vinyl covering and gold lettering for \$21.00, plus \$5.00 post.

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A flower arrangement by Shirla Johnson

Banksia occidentalis, *Beaufortia sparsa* and *Anigozanthos flavidus*.

