



Isopogons and Petrophiles



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Contents

Editorial	55
Introduction to isopogons and petrophiles	57
What distinguishes an isopogon from a petrophile?	65
21 in 21: recent additions to the species lists	70
Where to see isopogons and petrophiles: a guide to public gardens	74
Successfully growing isopogons and petrophiles in your garden	80
Why not try containers?	84
New and exciting isopogons for your garden	89
A guide to grafting isopogons and petrophiles	93
ANPSA Biennial Conference 2022	100
Book review – Plants of the Subtropical Eastern Australia	101
ANPSA Isopogon and Petrophile Study Group	102

This issue has been produced and written by Catriona Bate and Phil Trickett, joint leaders of the ANPSA Isopogon and Petrophile Study Group. All photos were taken by Catriona Bate unless specified otherwise.

Photography

Front cover: *Isopogon nutans*, a new species.

Back cover: *Isopogon sphaerocephalus* ssp. *lesueurensis*, the Lesueur Isopogon, a new subspecies.

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Editorial

Catriona Bate and Phil Trickett

Catriona and Phil have been joint leaders of the Australian Native Plants Society (Australia) (ANPSA) Isopogon and Petrophile Study Group, since 2015. Since retiring from Canberra to the NSW south coast (Murrumarang land of the Yuin people) about a decade ago, they have established a large native garden and grow a wide range of Australian plants.

Frustrated in their attempts to grow the beautiful Western Australian species they fell in love with on visits west, Phil began grafting WA species onto eastern rootstocks around 15 years ago. Despite expert advice that grafting banksias was not possible, he began with banksias and eventually achieved success with them. He now also grafts eremophilas, hakeas, dryandras, prostantheras and grevilleas and is a leading grafter of isopogons and petrophiles. Phil's grafts can be found in their Little Forest garden at Milton, NSW. He has also supplied grafts to the Australian Botanic Garden at Mount Annan in Sydney and many of his grafted banksias feature in the new Banksia Garden at the Australian National Botanic Gardens, Canberra.

This special issue of *Australian Plants* is all about isopogons and petrophiles. It is an especially useful primer because it brings a wide range of up-to-date information together all in one place in an overview of both genera.

The most spectacular species come from Western Australia and therein lies the reason why they are not commonly found in gardens. Like WA banksias, they are difficult to maintain away from their homeland due to their intolerance to root rot pathogens such as *Phytophthora cinnamomi* which thrives in warm soils exposed to summer rain. Eastern soils tend to lack the perfect drainage typical of southwest WA soils which magnifies the problem. The resultant lack of success in east coast gardens in particular has led to isopogons and petrophiles being labelled as fusspots, which are just too touchy to bother trying to grow. We consider this an unfair assessment, as, just like eastern banksias, the eastern isopogon and petrophile species tend to be hardy and long-lived.

Research and development to produce good specimens of isopogons and petrophiles for horticulture is way behind other, more popular, genera such as grevilleas, hakeas and, to a lesser extent, banksias. The Isopogon and Petrophile Study Group was not established until



2001, and grafting research has only been conducted in recent years. We regard grafting as essential to increasing the presence of these genera in gardens. The great news is that isopogons and petrophiles are easy to graft. It is important that this grafting work translates into the introduction of commercially available grafted forms of the sought-after pink isopogon and petrophile species. A new hardy rootstock, *Isopogon* 'Coaldale Cracker', has tremendous potential as a rootstock for the spectacular western isopogon species.

There is so much to like about isopogons and petrophiles. They are unique, intriguing and uncommon plants which repay closer inspection. It's hard to go past those stunning flowers and the sheer number of flower heads, but the differences in foliage across the species are also endlessly fascinating.

On top of all this, both genera are eminently suited to modern gardens. There are so many low and small-to-medium species suitable for feature ornamentals, massed plantings or pots. There are so many which have a mounded or rounded shape which stays neat and compact. Larger species can easily be kept to any size with judicious pruning. Selected forms are now becoming available so that we can enjoy the very best forms of the most attractive species and dwarf forms. Given the right conditions they are hardy, pest-free, drought tolerant and only need to be pruned occasionally. The ease with which they can be grafted means that even those with less-than-ideal conditions can grow a range of species.

Perhaps the most exciting thing about isopogons and petrophiles is that we are in the midst of a fascinating age of discovery. Steady work to resolve taxonomy, considered underdone in both genera, will continue to clarify species and genera thus bedding down the taxonomy. Are there other new species out there still waiting to be discovered and described? In addition, there is still so much to find out and document formally, for species and genera, about a never-ending list of subjects including (but not restricted to) the determinants of fertility, triggers for germination, root pathogens, the function of certain floral structures in some species, flowering times, pollination, the presence or absence of lignotubers, propagation (e.g. germination times, nursery conditions, grafting), cultivation (e.g. best forms and species, pruning, longevity, use of containers, frost), differences between the genera, responses to fire and effects of climate change.

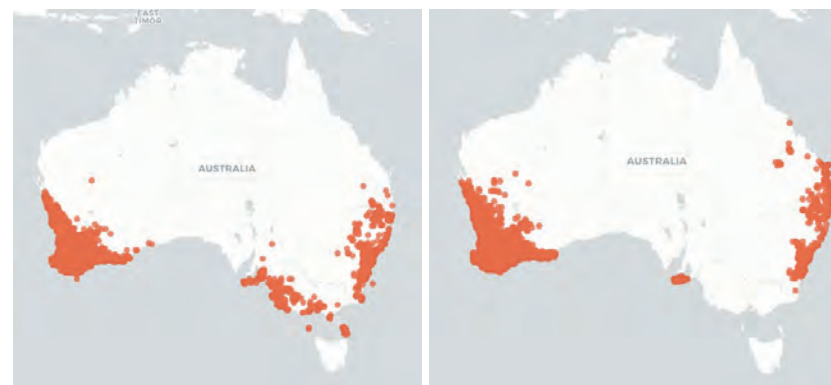
The articles in this issue were written by us but draw on the knowledge and experience of *Isopogon* and *Petrophile* Study Group members.

Introduction to isopogons and petrophiles

Isopogon and *Petrophile* are remarkably similar genera. These erect woody evergreen shrubs are endemic to Australia. Commonly known as drumsticks or coneflowers (isopogons) and conesticks or conebushes (petrophiles), prominent flowers are followed by brown/grey conical fruits. Their beautiful flowers, leaves and form have fascinated for over two centuries. However, isopogons and petrophiles are little known and little grown compared to other genera.

There are currently 39 species of *Isopogon* including 11 subspecies and two varieties. *Petrophile* has even greater diversity with 66 species including nine subspecies. As with many genera the greatest number of species occurs in southwest Western Australia. In fact, some 90% of taxa occur only in Western Australia.

Isopogons and petrophiles are mostly found in temperate southern Australia. A small number of species occur in subtropical and semi-arid areas. Some species grow on offshore islands, such as Fraser Island, Moreton Island and North Stradbroke Island (*Petrophile shirleyae*), Kangaroo Island (*Petrophile multisecta* and *Isopogon ceratophyllus*) and Flinders Island in Bass Strait (*Isopogon ceratophyllus*).



Distribution of *Isopogon* (left) and *Petrophile* (right). Maps courtesy of Australian Virtual Herbarium.

The genera generally co-occur. The exception is the south coast of mainland Victoria and South Australia where only isopogons are found in the wild (a single species, *Isopogon ceratophyllus*). They grow in well-drained ironstone, limestone or sandstone soils which are sandy or gravelly. Most species prefer full sun although some occur in open forest understorey. Heath, such as WA kwongan, or dry sclerophyll forest are common habitats.



Characteristics

The most striking feature of isopogons and petrophiles is their large round flower heads comprising dozens or even hundreds of individual tubular flowers. Ranging in length from around 10 mm to 45 mm, floral tubes split into four segments and peel back from the style (pictured, right) much like a banana, curling to create a decorative knot or bow effect. This reveals the pollen presenter which is a distinguishing feature of these genera. Flower colour is pink (WA species only), yellow or cream/white, and the colour inside a floral tube can vary from its external hue. Isopogons and petrophiles are generally prolific flowerers with numerous terminal or axillary flower heads. Flowers mostly appear in the second half of the calendar year, peaking in spring. They make excellent, long-lasting cut flowers.



Isopogon dubius



I. mnoraifolius



I. mnoraifolius

Round flower heads in bud are a distinctive feature, sometimes appearing right after the previous flowering. They can be massed together along stems or are terminal. Buds display intricate cone scale arrangements in chequerboard or Fibonacci spiral patterns. At the other end of the flowering cycle, they turn into spent fruits, good for floral decoration.



P. fastigiata
(Photo Liesbeth Uijtewaal)



I. fletcheri in bud



I. dubius



I. dubius as flowers emerge



P. ericifolia

Foliage is another notable attribute. Incredibly variable, it is no surprise that most specific names refer to distinctive leaf characters. Leaf colour ranges from blue-grey (such as *P. glauca*, right) to khaki to dark green to lime green. Leaves can be simple, divided or multiply divided. They can be flat or terete, glabrous or hirsute. Leaf length ranges from less than 10 mm to around 30 cm. Most species have firm or stiff leaves but only a few are highly prickly.



P. glauca





Clockwise from left: *P. drummondii*, *P. carduacea*, *P. ericifolia*, *I. ceratophyllus*.

Isopogons and petrophiles can be prostrate, low and ground-hugging, small shrubs or medium shrubs. Species range in height from prostrate to as tall as 3–4 m but most actually only grow to around a metre. There are only a handful of what could be considered larger species (*Isopogon dawsonii* and petrophiles *P. sessilis*, *P. pulchella* and *P. diversifolia*).



Petrophile prostrata

The majority of isopogons fit into the small to medium range (± 1 m) or medium shrub size (± 1.5 m). Petrophiles are generally smaller with the majority of species in the small to medium range (± 1 m) or low (± 0.5 m). In habit, isopogons and petrophiles can be tall or columnar but are most commonly compact or mounded.



Petrophile ericifolia

A lack of nectar means isopogons and petrophiles attract insects rather than birds. They offer a protein-rich pollen reward on prominent pollen presenters. The structure of pollen presenters varies across species, especially in petrophiles. Pollinators are considered to have influenced the evolution of specialised pollen presenter structures to cater for individual vector species in one group of petrophile species known as *Arthrostigma*. Another important function for the pollen presenter is to change colour from yellow to orange-red to prevent insects visiting flowers which have already been fertilised. As insects do not see red they will ignore presenters of this colour.

Conservation

Like other endemic genera, isopogons and petrophiles face increasing threats into the future. Chief among these is changing climate (especially more frequent and larger fires) and increasing development. Around one in four isopogon species and one in five petrophile species are currently considered to be under some form of threat.

Nationally there are five species (three isopogons and two petrophiles) currently at the highest level of threat i.e. at risk of extinction and specially protected. All occur in southwest Western Australia with one exception (*I. fletcheri* from NSW). In WA, species are highly susceptible to dieback (*Phytophthora cinnamomi*), increasing land clearing, small populations





or geographically restricted species, and unprotected locations. In eastern Australia the picture may look better but jurisdictions have given locally uncommon species threatened status (e.g. *I. prostratus* in Victoria). Eastern isopogons and petrophiles tend to occur in fire-prone or built-up areas and so can easily become locally threatened. Population pressure and development is a concern in eastern Australia where the distribution of these genera coincides with the distribution of the population.

Isopogon uncinatus is Australia's rarest isopogon and was thought to be extinct until it was rediscovered in the 1980s near Albany on the WA south coast. Threatened by inappropriate fire regimes, drought, recreational activities and grazing, its key threat is considered to be phytophthora (dieback fungus). Its ongoing decline and potential for targeted recovery prompted its inclusion in a select list of the top 100 Australian plant species at risk of extinction in 2020. *Isopogon robustus* occurs towards Kalgoorlie and is threatened by exploration and mining activity. *Isopogon fletcheri* occurs in the Blue Mountains of NSW and is threatened by urban runoff, possible weed invasion, and recreational pursuits such as rock climbing.



I. uncinatus. Photo: Margaret Pieroni.



I. fletcheri. Photo: Denise Krake.

Threatened petrophiles include *Petrophile nivea*, known only from a single locality to the south of Eneabba north of Perth. *Petrophile latericola* from near Busselton south of Perth is threatened by habitat degradation, phytophthora and weed invasion.

There are an additional 13 petrophile species plus another eight isopogon species from Western Australia in Priority Flora Lists. Classed as possibly threatened, these species are at risk but require further research and evaluation before they can be moved up the conservation ranks. Of these, the need for further research is considered urgent for around half (six species) of the priority petrophiles and two of the priority isopogons.

Fire ecology

Increasing fire intensity, extent and frequency in the context of climate change is a growing threat to isopogon and petrophile populations in Australia. The megafires along the eastern coast and ranges in the Black Summer of 2019–2020 coincided with the distribution of isopogons and petrophiles from northeast Victoria northwards. Perhaps the most catastrophic damage occurred in Western Australia's Stirling Range National Park, home to an amazing 13 isopogons and 21 petrophiles (including three possibly threatened species), where about a third of the park was destroyed.

Isopogons and petrophiles have developed adaptations to fire. They survive by resprouting and/or releasing seed banks into the soil. Seed banks are protected within cones – external woody cone scales protect seed stored in petrophile cones and woolly or hairy fibres and thickened external cone scales protect the seed of isopogons. A soil-surface environment of litter or mixed ash maximises seedling establishment.

For post-fire recovery, resprouters rely on a lignotuber or woody root swelling containing buds from which new stems may sprout, as well as stores of starch that can support a period of growth in the absence of photosynthesis. Reseeders rely on large seed banks accumulated over time and extensive seedling establishment. Although not well documented, the presence of a lignotuber appears to be less common in *Petrophile* than in *Isopogon*.

Recovery from the megafires has been helped by good rains along the east coast. The resprouter species were the first to begin and they have bounced back strongly. Only seven months after the fires, plants had 10–20 cm of new growth. Among the resprouters, *I. anemonifolius* was by far the fastest to recover, with larger plants flowering again only nine months after incineration. The reseeders were slower, with the first tiny seedlings appearing around nine months on and seedling production generally patchy. However, after a year or more, many more seedlings had appeared near killed parents. The most prolific reseed species was *P. sessilis*.

There is, however, a limit to the extent to which isopogons and petrophiles can recover from serial serious fires. Resprouters risk lignotubers being killed by intense fire. They can produce new offspring post-fire although seedlings take longer to begin flowering and may be outcompeted by seedlings of reseed species. The number of new seedlings is also less than in reseeders. Since the Black Summer we have not yet observed any resprouters producing new seedlings.



Reseeder seedlings require high seedling establishment and sufficient numbers reaching reproductive maturity to establish new seed banks.

When fires are too frequent or too intense, isopogon and petrophile populations decrease or become locally threatened. For highly restricted populations, this is an existential threat. The two most important factors determining change in population numbers and density are the age at which a stand is burned, and the proportion of seedlings which survive.

- Resprouters eventually senesce and die so must reproduce themselves to maintain populations. New plants need time to grow a lignotuber (which takes years to be able to tolerate fire) and to produce new seed banks. Studies of *I. anemonifolius* indicate that intervals of at least 12–13 years between low intensity fires and 15 years for hotter fires are needed for population stability.
- Reseeders need enough time between fires to grow and renew the seed bank. Studies of *P. pulchella* indicate that 5–8 years between fires (longer if seedling establishment is low) may be required.



Isopogons after fire: left, resprouting (*I. anemonifolius* nine months later); right, reseeding (*I. anethifolius* 9–10 months later).



Petrophiles after fire: left, resprouting (*P. canescens* one year later); right, reseeding (*P. sessilis* 13 months later).

What distinguishes an isopogon from a petrophile?

It's a question often raised because plants from these genera look similar and grow together. Isopogons and petrophiles can be difficult to tell apart, with similarities greatly outnumbering the differences. Both in the *Proteaceae* family, they are characterised by the presence of numerous flowers usually in condensed cones, as well as a true floral tube and a unique pollen presenter close to the terminal stigma. Their most obvious feature is the 'ball on a stick' (i.e. the cones on their stems). Hence the common names drumsticks or conesticks.

Early botanists treated them as a single genus, *Atylus*, referring to a lack of nectar glands. In 1810 Robert Brown formally separated them into two genera, *Isopogon* and *Petrophila* (*Petrophile*).

The key morphological characteristic taxonomists rely on to separate the two genera is a differing internal structure in the fruit or small cones (each of which potentially holds hundreds of seeds), particularly the cone scales which cover the outside of the cone. In isopogons, cone scales are deciduous and in petrophiles, cone scales are persistent. The different fruiting and seed dispersal processes involved may be described as follows.

Isopogon – after spent flowers drop, cone scales thicken slightly to provide a protective covering over the outer surface of the cone. In seed dispersal the outer layer of the cone disintegrates, leaving behind on the stem only a woody core much like an apple core (minus seeds). As well as the seed, much of the 'packing' material around the seeds plus the external cone scales drop to the ground.



Isopogon seed dispersal:
before: *I. anethifolius*; after: *I. anemonifolius*, *I. linearis*, and *I. cuneatus*.

Petrophile – after spent flowers drop, cone scales stay firmly attached to the core and thicken substantially to become woody. In seed dispersal the overlapping woody cone scales open slightly to allow the release of seed. Overall, the cone looks much the same as before seed dispersal. At this stage, petrophile cones look somewhat like a familiar pinecone (although in botanical terms, they are poles apart).





Petrophile seed dispersal: left: before (*P. semifurcata*); right, after: (*P. pulchella*, *P. macrostachya*, *P. drummondii*).

Isopogons and petrophiles both tend to hold on to their seed for years to build large seed banks, not dispersing the seed until the plant or a stem or branch dies due to fire, breakage or other cause. This means specimens are rarely at the right stage after seed dispersal to allow us to easily confirm the correct genus in this way.

There are other, less definitive, characteristics we can use to differentiate between the two genera.

- **Cone shape** – isopogon cones are rounded and either spherical or cone shaped. Petrophile cones are generally always longer than they are wide (cone shaped). Petrophile cones can be quite long (up to 6–8 cm) and narrow.
- **Seed shape** – petrophile seeds are flattened; isopogon seeds are rounded like a grain of rice. Hair on these tiny seeds gives isopogon seeds (right top) a shuttlecock shape whereas petrophile seeds (pictured, right) are more like a frisbee.
- **Flower length** – individual petrophile flowers are shorter than isopogon flowers, commonly reaching only 10–15 mm in length compared to 20–30 mm for isopogons.
- **Flower opening** (anthesis) – when a flower opens with the perianth tube splitting into four and peeling back to reveal the pollen presenter, petrophiles tend to split all the way to the base whereas isopogons more generally only split part-way (perhaps one-sixth of the way). Because of this, styles are more obvious on petrophile flower heads, staying erect and sometimes persisting after the perianth segments have dried and fallen (pictured, right).



We are not alone in having difficulty distinguishing between the two genera. Over time, botanists have had to reclassify certain species to the other genus due to uncertainty regarding their placement. Examples are species (as currently recognised) *Petrophile seminuda*, *Isopogon inconspicuus* and *Isopogon gardneri*. In fact, the specific name of *Isopogon dubius* (Latin for doubtful) actually references early doubt regarding its generic classification. More recently a similar ambiguity was noted in the generic placement of a new species, *Petrophile vana*.

Since scientific study began, the genus *Petrophile* has long been considered most closely related to *Isopogon*. Bentham's 1870 description of each genus references similar species in the other genus. The landmark classification of *Proteaceae* by Johnson and Briggs in 1975 placed *Petrophile* and *Isopogon* together in subtribe *Petrophilinae* under tribe *Conospermeae* and subfamily *Proteoideae*.

While the morphological similarities of the two genera are clear, the strength of the association of *Petrophile* with *Isopogon* was loosened in 2006 with a new suprageneric classification of the *Proteaceae* by Weston and Barker based on molecular analysis using DNA sequence data. Still in the subfamily *Proteoideae*, *Isopogon* was transferred to a newly described tribe, *Leucadendreae* (with *Adenanthos*) and subtribe (*Isopogoninae*) while *Petrophile* was placed in tribe *Petrophileae*. An interesting difference between the two genera discovered in this analysis is that *Petrophile* synthesises pinitol, a polyol sugar, a rare trait in the *Proteaceae*. As DNA analysis continues to develop in the future, it will be interesting to see if this treatment stands.



Isopogon divergens



Petrophile seminuda

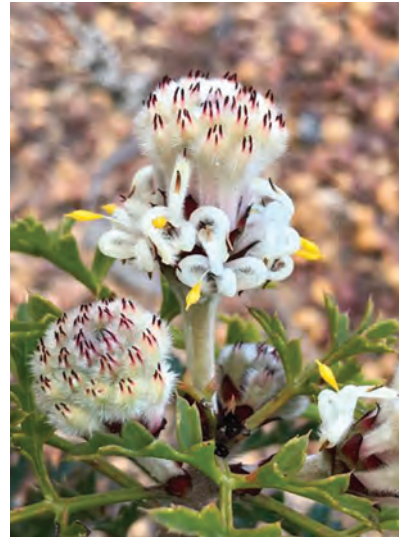




Petrophile drummondii



Isopogon dawsonii



Petrophile diversifolia



Petrophile pulchella



Petrophile teretifolia





21 in 21: recent additions to the species lists

In the first 21 years of the 21st century, 21 new *Isopogon* and *Petrophile* taxa have been published. This is a 22% increase in the number of recognised taxa, remarkable progress thanks to the efforts of a group of taxonomists in Western Australia, notably Barbara Rye and Michael Hislop. The new taxa are all endemic to Western Australia. Two are featured on the front and back covers of this issue.

Petrophile nivea (2002), pictured below, is a small shrub found only on one private property in Western Australia. It is noteworthy for its pure white, hairy flowers and dense zigzag sideways growth habit plus an early flowering period (May to August).



Petrophile nivea

Isopogon nutans (2020) is a new nodding species. A medium sized shrub, it has large pink flower heads and upright, terete leaves. It is one of only two species with pendulous flower heads. It is a highly ornamental addition to any garden.

Isopogon sphaerocephalus ssp. *lesueurensis* (2019), or the Lesueur Isopogon, is found much further north than *I. sphaerocephalus* ssp. *sphaerocephalus*, in drier habitats. It has a very restricted distribution. A highly attractive species growing up to around 1–1.5 m, it is compact with cream flowers and broad, soft, hairy leaves.

Isopogon pruinosus (2010) is distinguished by attractive blue-green leaves and a compact shape. The specific name refers to what appears like a white frosting on the leaves. It is a spreading shrub up to 2 m with pink flowers, found south-east of Perth.



Isopogon pruinosus ssp. *pruinosus*

Isopogon robustus (2005) is unusual because of its rather remote location in the Parker Range between Hyden and Coolgardie. It has remarkably thick leaves and large pink flowers. The sole population is threatened by mining and exploration activity.

Petrophile globifera (2011) is one of a number of species with similarities to *Petrophile ericifolia*. This one is of interest for its spherical flower heads which are particularly obvious because they are borne on stems with short leaves lying against stems. It grows to around 1 m high with cream to yellow flowers and is found north of Perth, in the Three Springs area.

Most of the newest taxa are considered to be at risk and in need of conservation. Almost two-thirds of these have priority status of three or higher, with three (*P. nivea*, *I. robustus* and *P. latericola*) declared threatened. Taxonomic work is a crucial driver of conservation. Providing scientific names and descriptions stimulates surveys and herbarium vouchering, which in turn helps direct conservation efforts which can lead to the discovery of new populations.

Hardly a romantic story about roaming southwest WA discovering a slew of new species as Drummond and Preiss did in the 1830s, it has mostly been a case of new work examining existing collections. There were only three completely unique new collections made since the last major revision of the genera. As well as yielding new species, the research has allowed longstanding taxonomical tangles to be resolved. It has led to historical concepts being reinstated or current ones being dropped



(reduced to synonymy). Of these, all are endemic to southwestern WA and the majority belong to *Petrophile*. This brings the current totals for each genus to:

- *Isopogon* – 39 species including 11 subspecies and 2 varieties
- *Petrophile* – 66 species including 9 subspecies.

Some of the key taxonomic changes since 2000 to note are as follows.

- A plant widely recognised by native plant enthusiasts as *Petrophile longifolia*, a low bush with creamy-yellow flowers and distinctive long, terete upright leaves held high above inflorescences, is now *Petrophile filifolia*. The prostrate form is now *Petrophile prostrata*. Another similar species, *Petrophile juncifolia*, has been reinstated.
- The highly variable *Petrophile brevifolia* has been more tightly defined and some forms have become new species, for example, *P. clavata*, *P. latericola* and *P. pilostyla*.
- The pink form of *Petrophile serruriae* is now *Petrophile axillaris*.
- A highly variable group of species allied with *Isopogon buxifolius* has been refined with the addition of two new species (*I. panduratus* and *I. pruinusus*) and the reinstatement of *Isopogon spathulatus*.
- *Isopogon heterophyllus* is no longer recognised, now included in *Isopogon formosus* ssp. *formosus*.
- *Isopogon drummondii* is now *Isopogon autumnalis*.
- *Isopogon teretifolius* ssp. *petrophiloides* is no longer recognised. The form with simple, terete leaves and similar nodding flowers is now *Isopogon nutans*.



Petrophile filifolia – this is subspecies *filifolia* which is found in the Stirling Range, WA.



Petrophile axillaris

Given the exceptional flora diversity of Western Australia where the majority of species occur, it is hardly surprising that there is still much to do. In the botanical backlog wait several putative new species with current phrase names. Four of these are isopogon species from the group allied with *Isopogon buxifolius* and one is a northern form of *Petrophile squamata*. In addition, there are many species or species groups known to require closer investigation including isopogons *I. attenuatus*, *I. buxifolius*, and *I. longifolius* and petrophiles *P. crispata*, *P. brevifolia*, *P. seminuda*, and *P. serruriae*. On top of this, twenty taxa need work before they can be moved up from priority status (1, 2 or 3) to threatened, endangered or vulnerable such as *Isopogon* sp. Canning Reservoir (Priority 1).

The last complete revision of both genera was by Don Foreman some 25 years ago (published in 1995 in Vol. 16 of *Flora of Australia*). In 2005, Rye and Hislop produced a taxonomic update of a large group of petrophiles (*Petrophile* section *Arthrostigma*) including a key. A 2010 follow up by Rye, Hislop, Shepherd and Hollister provided a complementary key for the remaining members of *Petrophile* occurring in Western Australia (excluding those belonging to *Petrophile* section *Arthrostigma*). Fragments of a revised key for *Isopogon* have also been published. Given that serial revisions have reduced the utility of Foreman's 1995 keys, updated overall keys for both genera are now required.





Where to see isopogons and petrophiles: a guide to public gardens

Although they are among the most spectacular Australian genera, isopogons and petrophiles are relatively neglected, under-appreciated and unknown. Displaying these plants in gardens is a good way to introduce people to these genera. There are some private gardens which present isopogons and petrophiles effectively – mainly in Victoria (particularly in the Grampians) and to a limited extent, in South Australia, Western Australia and NSW. However they are few in number and being private, not always easy to access. A major obstacle is the lack of permanency of these important gardens, with a change in ownership usually signalling wholesale garden destruction. Some important collections have already disappeared.

Public gardens are an important means of building not only awareness but knowledge of unique endemic Aussies like isopogons and petrophiles among Australians. It may even instil a desire to see them in the wild or grow them. Public visibility is key to encouraging conservation efforts. Effective coverage of isopogons and petrophiles requires a range of species, a good number of specimens overall, and good presentation.

Unfortunately, the presence of these genera in public gardens is decreasing over time. Over the past fifty years, key enthusiasts have been responsible for the inclusion of isopogons and petrophiles in public collections and sourcing a wide range of species; however, keeping that going in the long-term is a real issue. Further, volunteers are often necessary for ongoing maintenance. There are several examples of gardens which no longer have the isopogons and petrophiles they had even ten to twenty years ago; this includes government gardens as well as community gardens. In regions with less-than-ideal growing conditions, keeping WA species alive long term is difficult. Although rarely done, in the case of isopogons and petrophiles, grafting is an easy solution to this problem.

Perhaps the best public garden display of isopogons and petrophiles in Australia is currently at **Pangarinda Botanic Garden** near Wellington, South Australia. There are over 15 species in the garden, with roughly equal isopogons and petrophiles. The garden specialises in plants from low rainfall areas of South Australia and southern Western Australia and has a focus on conserving Australia's threatened flora, especially from WA hotspots where biodiversity is particularly vulnerable. Located on a sand drift by the Murray River, Pangarinda has the ability to replicate the plants' natural conditions with excellent drainage, low nutrient levels and good rainfall infiltration.

Contributing to the impressive impact of this isopogon and petrophile display is the way these genera have been grouped together in massed plantings. There are multiples of just about all species. The plants themselves are particularly attractive forms, for example, flower heads are particularly deep in colour or are relatively large. Foliage is also especially attractive, the deep green colour perhaps reflecting excellent local growing conditions. Finally, the plants are mature, all with a pleasing shape. Many of the species have a mounding or rounded habit naturally and the plants are relatively dense likely due to low nutrient levels. This negates any need for pruning, which would be too resource intensive for a community garden run by volunteers.



Petrophile brevifolia shrubs, Pangarinda



A particularly attractive form of *Isopogon cuneatus* at Pangarinda.

Particular highlights at Pangarinda are *Isopogon cuneatus* (pictured above), *Isopogon* 'Stuckey's Hybrid', *I. dubius*, *I. scabriusculus*, *Petrophile biloba* and *P. fastigiata*. The garden also makes a feature of lesser-known species such as *Petrophile drummondii*, *P. brevifolia* and *I. axillaris*. Most of the isopogons and petrophiles are in the southern



sandplains section, but they are also scattered elsewhere and also feature in the display near the southern gate where plants have been selected for visual appreciation. Spring is the best time to appreciate the spectacular flowering but from winter on you can enjoy *I. cuneatus* in flower as well as early flowers of a range of species plus the buds which in most species are highly attractive.



Petrophile biloba



Isopogon 'Stuckey's Hybrid'

Another public garden which uses massed displays to great effect is the **Australian Botanic Garden at Mount Annan** in southwestern Sydney. Here the species are eastern. A relatively new, large garden on a slope dotted with large rocks contains over sixty isopogon plants grouped together in a natural way. The species include *I. anethifolius*, *I. anemonifolius*, *I. dawsonii* (the tallest isopogon species) and *I. petiolaris* (prostrate). These four contrasting heights work well together and it is a great use of a lesser-known prostrate species.



I. dawsonii, *I. anemonifolius*, and *I. anethifolius*, Mount Annan. Above, in autumn, below, in spring.





The area is a study in yellow in spring, punctuated by the cream flower heads of *I. dawsonii*. The green foliage impresses year-round. The deep emerald-green colour of *I. dawsonii* is a lovely foil for the brilliant pea green of *I. anethifolius*. These species both have long, soft, narrow leaves with varying foliage texture provided by the more intricate patterns of the other species.

The Australian Garden at the Royal Botanic Gardens at Cranbourne, Melbourne, has also used massed displays of eastern isopogons in its theme gardens. A raised bed of *Isopogon anemonifolius* 'Woorikee 2000' was an original feature of the Future Garden which explored the possibilities of plant manipulation to produce new varieties of plants not seen in the wild. In the Dry Terrace of the Water Saving Garden a display of *Isopogon anethifolius* (again a low-growing form) was used as an example of what can be achieved with plants that, once established, require little or no watering other than natural rainfall. A group of *Isopogon anemonifolius* 'Little Drumsticks', another cultivar, nestles among the flat rocks in one of the eucalypt gardens on the western side of the gardens. A tall plant of *Petrophile biloba* grows against a huge rock in the Weird and Wonderful Garden which contains many hard to grow, rare and unusual plants. Cranbourne has also used isopogon species in planters and pots to illustrate how to create green space in small areas. They also showcase the local species *I. ceratophyllus* which pokes its shaggy, spiky low head up in natural bushland along the path up to the Trig Point Lookout. Unlike the main garden area, the deep sand of the hillside here is well-suited to this species and would also suit WA species. A new isopogon and petrophile grafting program is now beginning to produce hardier display plants of WA species for the main garden.

Melton Botanic Garden in outer Melbourne currently has 13 species in the garden, six isopogons and seven petrophiles. This relatively young community garden specialises in plants that tolerate a dry climate and low water conditions, both local and international. The Western Australian and South Australian beds have excellent displays of *Isopogon scabriusculus*, *Petrophile biloba*, *P. ericifolia*, *P. filifolia* and *P. fastigiata*, generally in multiples of three. The display specimens are quite dense and compact despite vigorous growth, perhaps due to low nutrient levels. This garden has the advantage of local conditions highly suited to the needs of WA species. They have selected particularly attractive forms of the species and all have deep green, healthy foliage with a naturally neat shape that needs no pruning.



Above and left:
Isopogon scabriusculus
flowers (Photo:
Barbara Pye) and
shrub, Melton

At the **Western Australian Botanic Garden** at Kings Park, Perth visitors have to penetrate deep into the gardens to find some impressive mature specimens of *Isopogon trilobus*, *Petrophile filifolia*, *Petrophile axillaris* and *Petrophile drummondii* scattered around. The critically endangered new species *Petrophile latericola* is a special feature in the endangered species garden. A spectacular image of *Isopogon cuneatus* can be seen but no actual specimens, likely reflecting the notoriously difficult growing conditions in Perth for most of the WA *Proteaceae*.



Successfully growing isopogons and petrophiles in your garden

Growing isopogons and petrophiles in cultivation is no different from growing banksias or grevilleas. The same issues arise according to whether the species selected are eastern or western, and whether your climate is Mediterranean, with rain mostly occurring in winter, or summer-wet. Many areas do not fit exactly into one of these two broad categories, but growers should consider the propensity to receive substantial summer rain as a key factor in the choice of isopogons and petrophiles in your garden.

Isopogons and petrophiles require little attention once established. They generally do not require fertilising in the ground, and many require little or no pruning, naturally retaining a compact, neat habit. However, they do respond brilliantly to heavy pruning, which means that growers can prune to shape as desired. Pruning, particularly of the larger species such as *Isopogon cuneatus*, *Isopogon dawsonii* and *Isopogon latifolius*, is recommended and increases the number of inflorescences. However, pruning must be done straight after flowering, as isopogons and petrophiles often set their flowering buds for the following year's flowering very soon after flowering. Delaying pruning too long may result in next year's flowering buds being removed.



Isopogon bed in the garden of Mark and Carolyn Noake, Moruya NSW.

The key to success is take your climatic conditions into account. Choose the species most appropriate to your climate and provide the best possible drainage. The best guarantee of success with WA species is to choose grafted plants if possible.

The current profusion of ungrafted WA plants being sold in NSW and ACT nurseries shows that most purchasers of native plants ignore (or are oblivious to) the unsuitability of such species in those climates. The result, consistent failure, is ultimately detrimental to the uptake of native plants over tougher exotics, a situation that will not change until WA plants are available in grafted form.

For isopogons and petrophiles, work is now being done to develop good cultivars and good graft combinations. Grafting is so successful that there is no reason why it should not be commercially viable. If we can encourage commercial production and develop demand, we should see better choices in nurseries and higher long-term growing success rates.

Summer-wet climates

Locations where rain falls in summer into warm soils (sometimes in heavy downpours over several days) are a challenge for WA isopogon and petrophile species, but it is not impossible to grow them in such conditions in NSW, ACT, Queensland and parts of Victoria.

Wet and warm soils provide the perfect environment for root rot pathogens to thrive. The good news is that the eastern species are largely immune to pathogens like *Phytophthora cinnamomi* and actually thrive in wet summers as long as water drains away well. Prolonged periods of constant rain, such in 2020-21, can still be a challenge. However, western species of isopogons and petrophiles bitterly resent such conditions. Deaths are generally quite sudden after summer rain, often in the following two weeks. Humidity is often blamed for such deaths but it is the roots which fail due to rotting roots starving the plant of nutrients.

To address this problem, try to maximise drainage. If your soil is not naturally free draining, try loosening your soil by adding sand if possible. Planting on steeply sloping beds is recommended if possible to ensure water drains away from roots. Mounding garden beds are also useful but the soils still need to be free draining. Alternatively, try growing WA species in pots. Isopogons and petrophiles generally do not require much water but keep watering to an absolute minimum in summer or do not water at all. Another good strategy to improve your chances of success is to choose eastern species or the western species shown to be the toughest in eastern Australia, including cultivars of these species.



Best species for summer-wet climates

Isopogon anemonifolius dwarf (Eastern)

Isopogon anethifolius (E)

Isopogon dawsonii (E)

Isopogon dubius (Western)

Isopogon formosus all forms (W)

Isopogon mnoraifolius (E)

Isopogon 'Coaldale Cracker' (E)

Isopogon 'Stuckey's Hybrid' (W)

Petrophile biloba (W)

Petrophile pulchella (E)

Petrophile sessilis (E)

Petrophile shirleyae (E)

I. dawsonii, *I. anethifolius*, *P. pulchella*

and *P. sessilis* are taller species which

can be pruned heavily to size and shape.



Petrophile biloba

Mediterranean climates

Australian gardens which experience a Mediterranean climate (dry summers and wet winters) are located in WA, SA and southern Victoria. Root rot pathogens have far less impact here so drainage is not as critical as in summer-wet gardens, though the more free-draining the soil, the better the success rates. Isopogons and petrophiles, once established, generally do well in dry or drought conditions.

When establishing isopogons and petrophiles, plant out in the wetter months of May, June and July after the summer heat has subsided. Water new plantings for the first 12 months but be very sparing with water over the warm summer months for all WA species. They hate wet feet in summer and will quickly succumb to overwatering in summer. Eastern species are more resistant to phytophthora and can be watered more liberally through summer months.

This climate gives you the luxury of being able to grow a wide range of WA isopogons and petrophiles. In fact, the list is unlimited although drainage should always be good. All of the species listed will withstand dry conditions very well.

Best species for Mediterranean climates

Isopogon anemonifolius dwarf (E)

Isopogon cuneatus all forms (W)

Isopogon dubius (W)

Isopogon formosus all forms (W)

Isopogon latifolius (W)

Isopogon divergens (W)

Isopogon scabriusculus (W)

Isopogon trilobus (W)

Isopogon 'Coaldale Cracker' (E)

Petrophile drummondii (W)

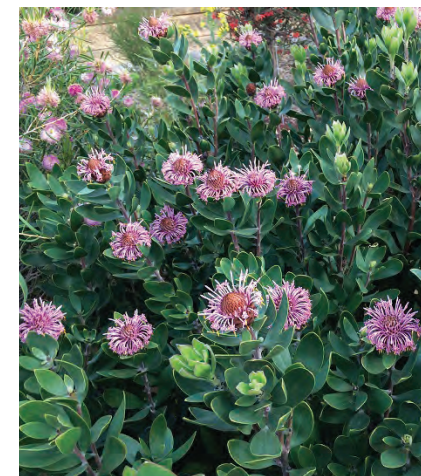
Petrophile ericifolia (W)

Petrophile fastigiata (W)

Petrophile filifolia (W)

Petrophile linearis (W)

Petrophile teretifolia (W)



Isopogon latifolius

Frosty climates

There are some isopogon and petrophile species which will withstand severe frosts and some will cope with moderate frost, although most species do best in more moderate climates. It is the frost rather than cold that does the damage. The longer the frost stays around, the more damage.

Protection from morning sun on frost days may help. Minimising irrigation over the winter period is essential as 'sappy' plants will suffer in these months. Plants with deep roots in well-drained soils are more forgiving of stresses like frosts. Once established, species like *Isopogon* 'Coaldale Cracker', *Isopogon* 'Stuckey's Hybrid' (pictured above) and *Isopogon dubius* have been proven to do particularly well despite winter temperatures as low as minus 10°C in places like Armidale NSW.

Best species for frosty climates

Isopogon dawsonii (E)

Isopogon dubius (W)

Isopogon prostratus (E)

Isopogon 'Coaldale Cracker' (E)

Isopogon 'Stuckey's Hybrid' (W)

Petrophile biloba (W)

Petrophile canescens (E)

Petrophile sessilis (E)



Isopogon 'Stuckey's Hybrid'



Why not try containers?

Although it is rarely done, isopogons and petrophiles are perfect in pots. This option is particularly appropriate for those of us who live in eastern Australia and/or have gardens subject to rain in summer, or with poor drainage. Other than using grafted specimens, this is by far the best solution for those in such locations who wish to grow WA species of isopogons and petrophiles.

These plants are very happy in containers and there is a huge range of species whose natural shape and habit works particularly well. Among the latest cultivars are small forms of some of the most attractive isopogon species and these are well suited to pot culture. A good demonstration of the way to use these species in pots has been on show at the Royal Botanic Gardens Cranbourne, Victoria. For many years an attractive planter with dwarf forms of *Isopogon anethifolius* greeted visitors just inside the entry (pictured, below). This shows how well these species can work, with foliage providing year-round impact. Cranbourne also used *Isopogon latifolius* in mixed container plantings of 'difficult to grow' plants to illustrate how we can use pots to create green space even in a concrete jungle.



Any pot, be it plastic, terracotta or glazed, can be used. Any size or shape will work. Check that the drainage holes in the bottom of the pot are large enough to allow good drainage. Placing some mesh or



Young plants of *Isopogon anethifolius* brighten up a corner of the patio.

flyscreen wire over holes helps stop ants and other bugs from entering. An inorganic mulch such as gravel or clay pebbles keeps the surface (and proteoid roots just below the surface) cool in summer, is long lasting and does not hold moisture against stems.

A good quality native potting mix is essential, but each time bags are purchased it is recommended that the pH is checked using a simple pH testing kit available from any garden centre or hardware store. There have been reports of some popular brands of native potting mix being far too alkaline or too acid. The pH should be between 5 and 7. A simple and quick test can avert a disastrous outcome.

Choosing a potting mix without water saving crystals can help prevent your pots becoming too wet. To maximise drainage, many gardeners loosen the potting mix further by adding perlite or horticultural sand. One-third perlite to two-thirds potting mix works well. Remember perlite should be thoroughly soaked with water before using as it is potentially hazardous in dry form due to fine airborne particles. This method of loosening the potting mix has worked brilliantly in our wet and hot summer months when we regularly receive 100 mm in a 24-hour period. Our potted WA isopogons and petrophiles are now surviving these wet summer periods, whereas too many were succumbing in 100% potting mix.



Petrophile ericifolia



Isopogon latifolius in mixed plantings at Cranbourne

Add slow-release fertiliser suitable for natives once a year. A dose of liquid fertiliser suitable for natives will also really pep them up if required.

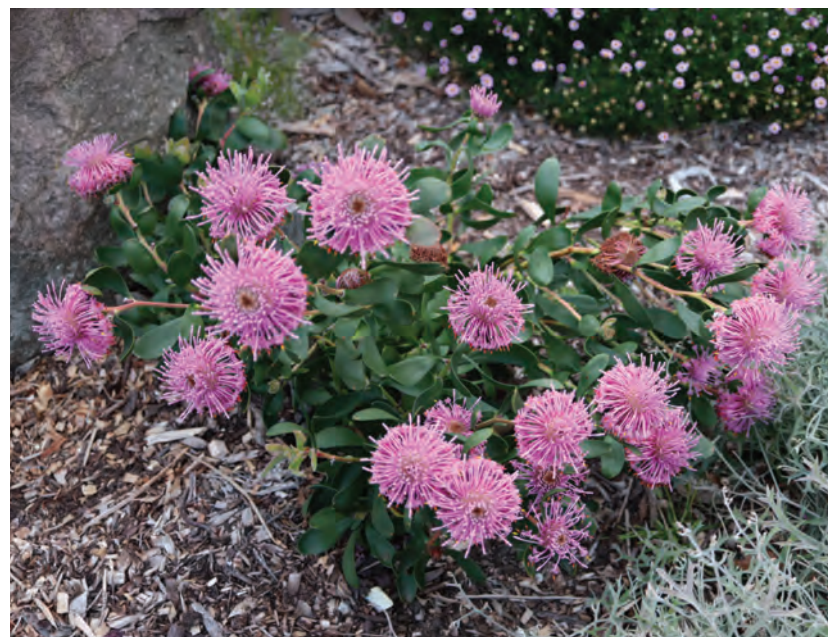
One of the advantages of pots is that they can be moved around. Isopogons and petrophiles in pots are tolerant of heat, humidity, low light, semi-shade and cold. They grow well under cover. In full sun, extra diligence is required with watering. In frosty areas, choose species that cope with frost for pots kept out in the open. In full summer sun, pots may need to be turned regularly so the same part of the pot does not bake every day.

The crucial part of growing isopogons and petrophiles in pots is to make sure the soil does not get too wet or stay wet for a prolonged period in warm weather. Don't drench your potted specimens every day, but check how moist they are. If possible, lift the pot to assess its weight as an indicator. Don't soak the entire pot if the bottom half is still moist, just water briefly to rewet the top half. Careful monitoring is your best approach; individual attention amply repays the investment. How often to water depends on how well-drained the potting mix is and the prevailing weather conditions. In summer, water every day with a very loose potting mix, or every few days with straight potting mix.

In winter, watering can be wound back to every few days or even less (larger pots may only need an occasional watering). Plants in unglazed pots or in baking sun will require more frequent watering. Raising pots on pot feet helps air circulation under the roots but is not essential.

Best isopogon species for pots – all of the most popular and spectacular WA species like *I. cuneatus* or *I. formosus*, or the cross *Isopogon* 'Stuckey's Hybrid', are great candidates for pots. Prune *I. cuneatus* each season to maintain a neat shape. You could try the rare and endangered white-flowering NSW species, *Isopogon fletcheri*. In tall pots, *I. prostratus* or *I. 'Coaldale Cracker'* (suitably pruned) will cascade down over the sides. Low forms and low cultivars of species like *I. anemonifolius*, *I. cuneatus*, *I. latifolius* or *I. formosus* are also excellent choices. In addition, we recommend *I. linearis*, *I. scabriusculus*, *I. baxteri*, *I. adenanthoides* and *I. gardneri*.

Best petrophile species for pots – in wide pots, *P. prostrata* or *P. filifolia* are very effective. They spread sideways and have long terete leaves which grow upwards from low flower heads. Both these species are better known by their former name, *P. longifolia*. For a dense, low mounding effect go for *P. ericifolia* or *P. glauca*. Of course, the well-loved *P. linearis* 'Pixie Mops' should be at the top of the list but the spectacular yellow-flowering WA species *P. drummondii* and *P. fastigiata* have just as much impact. From a large number of other good candidates, we also recommend *P. serruriae*, *P. squamata*, *P. striata*, *P. plumosa*, *P. biternata* and the Queensland species *P. shirleyae*.



Dwarf *Isopogon cuneatus*: what a great plant for a pot.



As far as we know, there are no isopogon or petrophile species unsuited to pot culture. Study Group member Liesbeth Uijtewaai grows a huge range in pots in The Netherlands. Her list includes sixteen isopogon species or cultivars (including the touchy *Isopogon* 'Candy Cones'), plus six petrophile species. Your choice of species is limited only by whether you can source them.

Isopogons and petrophiles will last in the same pot for years, depending on pot size. They do not suffer from pests or diseases other than phytophthora which should be under control if your drainage measures and controlled watering regime are working. Smaller pots can be upgraded to a larger one each year and the potting mix should be refreshed regularly (ideally every 1–2 years). Isopogons and petrophiles have good longevity too, living up to ten years and probably more with good care. They hardly ever need pruning, even the larger species, since they grow so neatly by nature. On the other hand, they respond brilliantly to heavy pruning should you wish to do so.



Petrophile linearis: 'Pixie Mops', the photographer's delight. Another great choice for a pot.

New and exciting isopogons for your garden

Both genera have many garden-worthy species with spectacular inflorescences and lovely foliage. But you are more likely to see their South African relatives such as leucodendrons, leucospermums and even the little-known aulax at nurseries in Australia, with only leading specialist native nurseries carrying isopogons and/or petrophiles. In practice, they carry only a limited range of isopogons.

Availability in nurseries seems to have decreased over time, with species for sale in the 1980s and 1990s now absent (perhaps reflecting a reduced interest among native plant enthusiasts or the reduced involvement of certain enthusiasts). Isopogons and petrophiles have also suffered from an ill-informed reputation as difficult, meaning gardeners hesitate to purchase them but will likely give a fussy WA banksia a go.

The Isopogon and Petrophile Study Group aims to stimulate interest in isopogons and petrophiles and encourage people to grow them in their gardens. We are always looking for new and better forms. Not only are we trialling plants with particularly attractive attributes and suitable sizes, but also plants of the same species from different areas to test for relative hardiness. We are also trying to get these new forms out into cultivation. Study Group member experience indicates that so far, petrophiles are more difficult to propagate and grow, thus making them more difficult to promote for cultivation. There is plenty of potential in both genera but it is a long-term work in progress.

The cultivation trials involve grafting. In terms of being able to grow these plants in gardens, it is important to understand whether grafting is feasible to enable them to be more widely grown and enjoyed.

Here are some exciting isopogons new in cultivation. Each of the WA isopogons recommended below is easily grafted using tough rootstocks. Hopefully in the not-too-distant future it should be possible to access grafted plants, allowing us to grow a larger range of species.

***Isopogon* 'Coaldale Cracker'** is a natural hybrid between the eastern species *Isopogon petiolaris* and *Isopogon mnoraifolius*. It has bright green soft foliage, numerous yellow axillary flowers in spring and never needs pruning. It grows up to around a maximum of 1.2 m. And wait, there's more...it has excellent tolerance for a wide range of conditions including severe frost, dry soil and wet soils. It is such a good plant that we decided to give it a cultivar name. If you think you cannot grow these genera, this is the plant to try. This hybrid is now used as a rootstock for grafting western species.





Isopogon 'Coaldale Cracker'

Compact forms of the pink stunners. The most well-known and widely grown species of isopogon include WA species *I. cuneatus*, *I. formosus* and *I. latifolius*. All are highly attractive pink flowering species with bright, relatively large flower heads. There are now small, compact forms of these popular species which work equally well in small modern gardens, in pots and rockeries, or as ornamental features in any garden foreground.

- *Isopogon cuneatus* flowers profusely. The straight species can grow up to 2.5 m with long canes best pruned to keep the plant compact. Lower versions are much more compact. Cultivar 'Pink Bouquet' grows to around 1.2 m by 1 m and in future there may be other forms available which are even lower.
- *Isopogon formosus* has lacy, intricate foliage with a columnar habit and is one of the tougher western species. There are a couple of more compact cultivars now available. 'Pink Sparkler' has lovely grey foliage and grows to 75 cm x 1 m. It produces axillary as well as terminal flowers for added effect. Similarly, 'Pink Profusion' is described as a dwarf grey form with height 0.2–0.5 m and width 0.5 m.



Isopogon 'Pink Sparkler'.
Photo: APS SA
Fleurieu Group

- *Isopogon latifolius* has the largest flower heads of all species. The species can usually reach 2 m or more in height, but the cultivar 'Lollypop' reaches only about 1 m by 1.2 m and is more densely bushy than the usual form. Buds are an attractive feature and can be coaxed into flower by applying sulphate of potash in spring.

***Isopogon* 'Candy Cones'** is a chance hybrid of *I. formosus* and *I. latifolius* found in seed raised in a South Australian nursery. It has unique mauve/pink flowers and deep green foliage and grows up to 1.2 m tall. Highly popular, in our experience this is a touchy plant requiring careful TLC, but is well worth the effort. In summer-wet eastern gardens, this should be grown in a pot.



Isopogon 'Candy Cones'. Photo: Mark Noake



Isopogon scabriusculus (right) is a naturally compact and neat western species which flowers profusely and reaches around 1.5 m (most commonly around 1 m by 1 m). The flower heads are an elaborate combination of pink and white flowers rimmed with a halo of bright reds, oranges and yellows (pollen presenters protruding from narrow pink floral tubes). Located at the base of graceful, upright narrow long leaves, the flower heads give an eye-popping display from amongst the foliage. All three subspecies are similar and well-suited to gardens.



Isopogon nutans has distinctive nodding or pendulous flower heads. This brand-new species is an exciting addition to the genus. Never previously cultivated, it grows to around 1.5 m high, and commonly 0.5–1 m wide. Superficially similar to *Isopogon scabriusculus*, its upright leaves are shorter and more numerous. Its gracefully nodding pink flower heads are quite different too. New flowers have a tuft of white at the end, and the flower head has a two-tiered structure as open flowers pull back together and new ones group at the front.



Isopogon 'Silvertops' (left) is the tentative name we have given to a natural hybrid between *Isopogon divergens* and *Isopogon gardneri*. Growing about 1.5–2 m, it has the large pink flower heads of the best western isopogon species. Likely to have hybrid vigour, its flowers have distinctive silver tufts which curve slightly over matt pink stalks somewhat reminiscent of tuckshop musksticks. Divided leaves are needle-like but not prickly.

A guide to grafting isopogons and petrophiles

Isopogons and petrophiles are similar to many Australian genera in that most species come from Western Australia and most of these WA species are unreliable as garden plants outside of their homeland. Growing plants successfully is vital to expanding both the popularity and range of isopogons and petrophiles in gardens. While addressing drainage can improve the longevity of difficult plants in cultivation, grafting onto tough rootstocks is the real solution. Grafting is a major tool in the reliable cultivation of exotic plants, notably roses, citrus and grapes – so it should be with our Aussie natives.

We are slowly seeing more grafted Australian plants available in nurseries, but the genera grafted are restricted to *Grevillea*, *Hakea*, *Eremophila* and *Eucalyptus/Corymbia*. No grafted isopogons or petrophiles are currently available in Australian nurseries to our knowledge.

While next to no work has been undertaken on commercially grafting isopogons and petrophiles, the Isopogon and Petrophile Study Group has recently been developing techniques, rootstocks and the species compatibility information required to produce hardy plants suited to a wide range of climates and soil types. It turns out that WA isopogons are one of the easiest genera to graft, similar in ease to eremophilas, and far easier than grevilleas and hakeas which many native plant enthusiasts successfully graft.

In the last three years, the Study Group has made great progress in the discovery of grafting compatibilities, particularly with isopogons. All the western species attempted have grafted successfully onto eastern rootstocks. However, finding rootstocks for petrophiles has proven more difficult than for isopogons, due to much lower strike rates for rootstock cuttings. The Study Group is now starting to produce some exciting results with a range of western petrophiles. The biggest issue for our trials is sourcing scion material.

The choice of rootstocks is vital to produce viable grafted plants. Chosen rootstocks must be tough to a range of conditions, especially summer-wet climates where WA species are most vulnerable on their own roots. Long-term compatibility is also very important so that growers can expect at least ten years' survival in their gardens.



Isopogon rootstocks and compatible scions

Three isopogons have performed best as rootstocks in grafting trials.

- *Isopogon* 'Coaldale Cracker' – the most adaptable of the three, being hardy to very wet and dry conditions and is frost hardy. It is highly suited for cutting grafts as it is able to quickly and reliably strike roots.
- *I. anethifolius* – a hardy, vigorous eastern species which strikes roots relatively easily. However, this species can be unreliable in heavy soils subject to high summer rainfall.
- *I. anemonifolius* – another hardy, eastern species which strikes roots readily. The larger forms tend to be tougher than the dwarf forms and these should be preferred as a rootstock.

Each of the above stocks has proven to be long-term compatible with most western isopogon species trialled as scions. Those which have been successful in trials so far are:

I. adenanthoides, *I. asper*, *I. axillaris*, *I. buxifolius*, *I. cuneatus*, *I. ceratophyllus*, *I. divergens*, *I. dubius*, *I. gardneri*, *I. latifolius*, *I. longifolius*, *I. nutans*, *I. panduratus*, *I. pruinosis*, *I. scabriusculus*, *I. sphaerocephalus*, *I. spathulatus*, *I. 'Stuckey's Hybrid'*, *I. teretifolius*, *I. tridens*, *I. trilobus*

Some scion species, however, do not appear to be compatible and require the addition of an interstock. In these cases, *I. cuneatus* is proving to be successful as an interstock on all three recommended stocks. Examples of scions requiring this treatment are *I. baxteri*, *I. formosus*, *I. linearis* and *I. 'Candy Cones'*.

Petrophile rootstocks and compatible scions

Petrophile grafting is at an early stage of development, but the Study Group has had success with a number of WA petrophile species.

For grafting petrophiles, we recommend two rootstocks:

- *P. pulchella* – a very hardy, adaptable eastern species. It is difficult to strike from cuttings, so rootstocks are best grown from seed. Identifying a form which strikes readily from cuttings would make cutting grafts viable.
- *P. sessilis* – also a hardy eastern species though not quite as adaptable as *P. pulchella*.

Petrophile scions which have been successful in trials so far are *P. acicularis*, *P. chrysanthus*, *P. diversifolia*, *P. filifolia* (often incorrectly labelled as *P. longifolia*), *P. glauca*, *P. prostrata* and *P. teretifolia*. So far,

one species has been shown to also require an interstock. *P. linearis* (Pixie Mops) can be successfully grafted using an interstock of *P. teretifolia*.

There are a number of other promising petrophile species currently being trialled as scions. Time will tell if they are long-term compatible but all are currently growing well as young grafted plants: *P. biternata*, *P. divaricata*, *P. drummondii*, *P. ericifolia*, *P. fastigiata*, *P. incurvata*, *P. megalostegia*, *P. plumosa*, *P. recurva*, *P. rigida* and *P. serruriae*.

Method

There are two grafting methods used for isopogons and petrophiles. The more traditional way is to grow the stock into a rooted seedling and then graft the scion (the species being grafted onto the rootstock) onto this seedling. The other way is to graft the scion onto a cutting of the rootstock and treat the resulting graft as a cutting. This is called a cutting graft. The Study Group uses a top wedge graft for both methods.

Cutting grafts have a number of advantages for the home gardener wanting to try grafting isopogons and petrophiles for the first time. The time and effort required to grow seedlings to use as stocks for the traditional approach is unnecessary, allowing for cheap and easy experimentation. Mistakes and failures have fewer consequences because you do not lose seedlings. Growers can choose a rootstock from their own garden, from a plant which is proven to be vigorous and hardy in their conditions. Given practice, cutting grafts are easier and quicker to execute than for the traditional approach. However, a prerequisite for using the cutting graft method is that cuttings of the chosen rootstock strike roots readily and reliably. Otherwise, the graft will fail. This is the problem so far with many potential petrophile rootstocks. At this stage, cutting grafts are perfect for isopogons but not recommended for petrophiles.

Because the rootstock already has roots, traditional or seedling grafts seem to be tougher to start with. The plant does not have to expend effort on rooting and can grow on quickly. The resulting graft is ready to plant out earlier than with cutting grafts, whereas cutting grafts require more time and care to grow on. For petrophiles, this traditional method is the recommended approach given the difficulty in striking roots on potential petrophile rootstocks. The most reliable way of growing petrophile rootstocks is therefore from seed rather than with cuttings. This traditional approach is also highly successful for grafting isopogons, as all three of the recommended rootstocks can easily be produced in numbers by cuttings.



Isopogon cutting grafts (after potting up): from left, *I. inconspicuus* (on *I. 'Coaldale Cracker'*), *I. linearis* with *I. cuneatus* interstock (on *I. 'Coaldale Cracker'*), *I. teretifolius* (on *I. 'Coaldale Cracker'*)



Isopogon traditional grafts: left, *I. adenanthoides* (on *I. 'Coaldale Cracker'*); right, *I. cuneatus* 'Pink Bouquet' (on *I. 'Coaldale Cracker'*)

Steps for successful grafts

1. Take a cutting of your chosen scion (the plant you wish to reproduce in grafted form). Select firm, semi-hard scion material and trim to around 5–8 cm in length. New tip growth should be avoided as this will tend to wilt quickly resulting in the graft failing.
2. Choose your stock
 - a. For cutting grafts, take a cutting from your chosen stock plant. This cutting should be chosen to match the diameter of the scion material, and should be around 8–10 cm in length. The bottom of the cutting should have at least one leaf node which will facilitate the formation of roots. This is no different to preparing any cutting. Remove all leaves from the stock cutting, apart from one leaf at the very tip of the cutting. All other leaves can be removed – be careful not to strip the bark when removing leaves.
 - b. For traditional grafts, choose a stock plant to match the diameter of the scion material. Identify a leaf on the stock which will mark the point where the scion will be inserted. Cut off the stock just above this top leaf, then remove this top leaf without cutting off the bud between the top leaf and the stem of the stock plant. This bud will be sufficient to sustain the tip of the stock plant while the graft union knits together. If this bud is removed, 'dieback' around the graft union can occur resulting in failure of the graft. Remove all leaves for 4 cm below the tip of the stock plant to easily facilitate the taping of the graft union. Try to ensure there are at least 3–4 leaves below this point so the stock plant remains healthy through the grafting process.
3. Cut a 10–15 mm slit down the middle of the stock but make sure this slit does not cut off the top leaf (cutting grafts) or cut through the top bud (traditional grafts).
4. Cut a wedge in the bottom of the scion stem of around 10–15 mm so the scion can be inserted into the stock.
5. Insert the wedge-cut scion into the cut at the top of the stock. Then tape the graft union using Parafilm or Nescofilm (cut tape into pieces of about 5 cm long and 1 cm wide) so the graft union is totally covered and is waterproof. The tape should be stretched as it is wrapped so the taping is tight and the tape adheres to itself.





Cutting graft – scion *I. dubius* grafted onto stock *I. 'Coaldale Cracker'*

Left: scion with wedge of 10–15 mm (inset, wedge)

Middle: stock cutting with top leaf intact (inset, leaf node at bottom)

Right: completed cutting graft



Traditional graft – scion *I. dubius* grafted onto stock *I. 'Coaldale Cracker'*

Left: scion with wedge of 10–15 mm (inset, wedge)

Middle: stock plant with stem cut (inset, bud at top of stem)

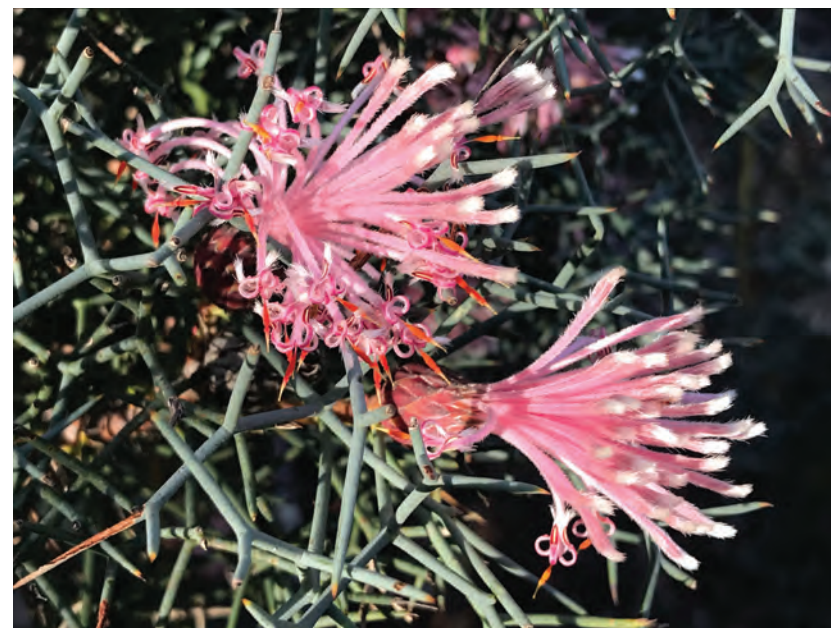
Right: completed traditional (seedling) graft



Post-graft treatment

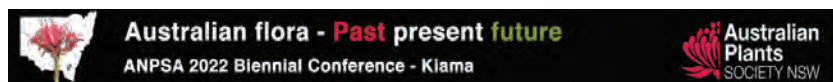
- For cutting grafts, treat the cutting graft as you do a cutting, i.e. nick the bottom of the stock, insert into Clonex Purple Gel for five seconds then place into cutting mix. Roots should appear on the stock within two months in the warmer months (may take longer in the cooler months). Once the cutting graft is potted up the graft should have taken and the plant can be grown as for a normal cutting.
- For traditional grafts, cover the scion and graft union with a snap-lock plastic bag, then place the grafted plant in a shady position protected from wind for 21–28 days. The snap-lock bag can then be removed but the uncovered grafted plant still needs hardening off in a protected position for another 2–3 weeks before placing into direct sunlight.

Study Group grafting trials are continuing. A focus is how to overcome apparent compatibility issues with the aim to eventually bring as many species with horticultural potential as possible into cultivation. With isopogons and petrophiles the list of such species is large. An important part of this process is encouraging more propagators to graft isopogons and petrophiles.



Isopogon gardneri





ANPSA Biennial Conference 2022 – Kiama, 11 – 16 September



APS NSW is excited to be hosting the next ANPSA Biennial Conference in Kiama in September 2022.

We aim to bring you a wide range of interesting speakers and enjoyable activities.

We will be operating at the highest Covid standards and guidelines to keep us all safe and healthy.

For further information, see the APS NSW website or send us an email: www.austplants.com.au, office@austplants.com.au.

Theme: Australian flora – past present future. Explore the flora of 40,000 years ago, understand opportunities and threats we face now and consider how the future might unfold, along with our role in that.

Location: Kiama, with the conference to be held at the Kiama Pavilion.

Excursions: Robertson Rainforest, Fitzroy Falls, Wollongong Botanic Gardens, Royal National Park, Kamay – Botany Bay National Park, Bulli Grevillea Park and native plant reserves in Southern Sydney.

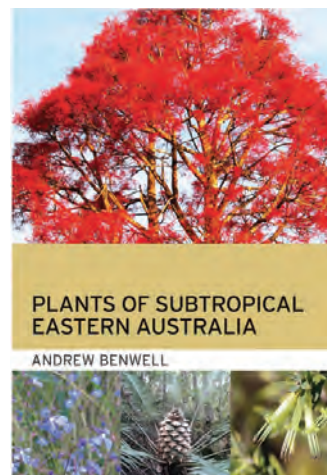
Pre and post conference tours: Lord Howe Island, Warrumbungles and the Pilliga, Blue Mountains, Sydney and the South Coast.

Registrations for the conference will open in February 2022, except for the Lord Howe Island tours which will require a \$255 deposit for:

- the pre-conference tour by 12 November 2021, with balance payable by 1 July 2022
- post conference tour by 21 November 2021, with balance payable 15 July 2022.

For further information, visit the APS NSW website (www.austplants.com.au/ANPSA-Biennial-Conference-2022) or send us an email: office@austplants.com.au.

Plants of the Subtropical Eastern Australia – Book review



By: Andrew Benwell

Published: 1 December 2020

ISBN: 9781486313655

Format: Paperback, 400pages

RRP: \$49.99

Publisher: CSIRO Publishing

Review by Robert Watt

An interesting premise of this extremely attractively presented book is the region the author has decided to cover in 'Subtropical Eastern Australia' (SEA). Rather than divide the region artificially

with reference to a state border, here we have a continual reference to a wide sweep of the eastern seaboard – from Gladstone in the north to Newcastle in the south, thus covering the NSW North Coast and South-East Queensland bioregions. With the eastern border of the Pacific Ocean and the Great Escarpment range to the west, we have a rather long and narrow (1000 km by 80 – 150 km) climatic zone that is reasonably warm and humid.

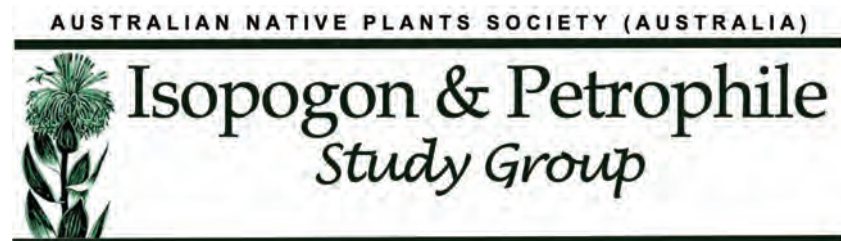
For an even greater understanding of particular areas within the wider scope of the book, the author provides climatic, topographic and geographic distinctions over the wider area to explain the flora of the various parts of the region. It is here that we begin to understand the reasons for looking at this area as a whole – the fact that over most of the wider region there is a richness of plant life. The author estimates that there are 3000 plant species or over 4000 different types of native plants at the level of subspecies or variety. This diversity over the whole area is due not to one or two areas being exceedingly species rich but rather the range of vegetation communities all being rich that contributes to the overall richness. He suggests that the broader region is a centre of plant endemism – supporting many endemic species and a substantial number of endemic genera.

But it is this reviewer's opinion that it is the way this book, of over 500 plant species of the area covered, has been brought together that shows its true value. Over the years bark, flower or family name have all been used to arrange species to facilitate identification or understanding of

where the plant 'fits in'. In this case the author has specifically noted that it is to assist in identification that species have been assigned a General Vegetation Type or habitat where they can be found that determined placement in the book.

There are twelve General Vegetation Types provided for the region but his treatment does differ between them. Thus, in the case of 'Subtropical Rainforest' for example, there is a concise but extremely good introduction; a list of examples of pioneer trees and shrubs with explanation; a number of pages of photographs of the trunks of mature phase trees that grow there because leaves are virtually impossible to obtain. Finally, photos of distinctive seeds, such as *Gemlina leichhardtii*, are also helpful for identification.

This is a book by one of the most respected Australian botanists and his years of immersion in his subject have allowed him to produce a book of excellence. Both the author and the CSIRO are to be thanked and congratulated for making *Plants of the Subtropical Eastern Australia* available. I highly recommend this book to all plant enthusiasts, both professional and amateur, who wish to identify the members of this diverse range of flora of the south eastern area of Australia.



If you enjoyed this issue of *Australian Plants* and are interested in learning more about these beautiful genera, you are welcome to join our study group. Whether it is observing, photographing or growing isopogons and petrophiles, you can help to research and document them by sharing your learnings with the study group. It's free! Our twice-yearly newsletters are sent out via email and later are posted on our website page.

Follow the link below to join the Isopogon & Petrophile Study Group. You can also find our newsletters here.

Website anpsa.org.au/iso-petSG/

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