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THE PETROPHILE ISSUE

THE TOP THREE: What are they? And which was our members' Number One? See our article.
Photos: Royce Raleigh, Fiona Johnson, Catriona Bate

Back issues of the Isopogon and Petrophile Study Group Newsletter are available at http://anpsa.org.au/iso-petSG/IPSG-news.html

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THE PETROPHILE ISSUE

Hello to all our members

It's a sad fact that there is barely a nursery in Australia you can walk into and find a petrophile plant to buy. And the common eastern species are particularly hard to acquire. Yet you can walk into Bunnings and buy a plant of *Aulax*, a genus no one has ever heard of and native to South Africa. There are only three species in *Aulax* and the scientists now tell us the DNA shows this genus is most closely related to *Petrophile*, instead of *Isopogon* as previously thought.

To us, our endemic petrophiles and isopogons are morphologically very similar. However petrophiles are much harder to find in nurseries and gardens than isopogons. The main reason for this is that isopogons seem to be easier to grow, and there are more of the highly attractive pink flowering species with large flower heads. Therefore they are more likely to appear in the nursery trade. However our access to both genera seems to have reduced over time, with long-time growers of WA proteaceae telling us that they used to be able to access and grow many more I&P species in the past.

The level of knowledge about petrophiles seems to be very low even among native plant people. The greater number of petrophile species compared to isopogon can be confusing. And there are many similar species and much taxonomic work yet to be done. Many WA species have a limited distribution and we are unlikely to stumble across them in the bush. But there are still plenty of easy to find and identify species! Here in the east they are easily found but even native plant experts have trouble distinguishing between species – however

this is a function of an overall lack of familiarity rather than any real difficulty. In this issue, Phil shows how to tell the difference.

Not all species have stunning floral displays. Yet petrophiles are great foliage plants, some would say the flower heads are a bonus rather than the main reason to grow many species of the genus. The eastern species grow in similar locations to the popular eastern banksia cultivars and there is no reason that they should be any more difficult to grow than these trendier plants. Some say the showier species are actually among the toughest e.g. *P. biloba* and *P. teretifolia* are among the most commonly grown species.

In this issue we celebrate the petrophile and bring it out of the shadow of its more familiar companion the isopogon. We hope that when you have finished reading this newsletter you will have a better understanding of these neglected plants plus a new appreciation and enthusiasm. And hopefully this will spread further within our Australian Plant Society and beyond.

There are many similarities between isopogons and petrophiles but also some fascinating differences. We look at what makes petrophiles distinctive, and where they come from. Catriona's article on the history of the genus discusses how botanists have debated over time on what, if anything, separates them. They have also made many changes to species as the science of botanical taxonomy has developed. Catriona also looks at the history of naming of petrophile species over the last 230-odd years. Peter Olde has delved even further into the taxonomic history of a few of the currently recognised species – the findings of the little-known French botanist Gandoger, a notable splitter, point to potential issues for further scrutiny.

We also look at the distribution and fire ecology of petrophiles plus conservation issues, and report on presumed natural hybrids. We even address the perennial question of how to say the word petrophile. Phil looks at how to propagate and grow petrophiles drawing on members' knowledge. Plus we report on where to buy petrophiles.

A highlight this issue is the result of our Study Group member vote for top petrophile species. It was a close result but three really stood out. Wouldn't we all love to have these in our gardens!

Our sincere thanks to those members who took the time to share their knowledge and enthusiasm for petrophiles. Given the lack of knowledge of this genus, this information is vital and it's great to have it documented. As a group we all need to increase our efforts to know, grow and promote this genus. We should all have some in our gardens. We need to encourage others to grow them too, starting with our Plant Society colleagues.

Catriona and Phil

How do you say it??

Catriona Bate

Petrophile?? we constantly get asked. Not the word as such, but how to say it. Is it PET-RO-PHILE or pe-TROPH-i-LEE?

It's confusing to have two alternatives – but not as bad as the genus *Alyogyne*, we've heard four or five different ways to say that. Pronunciation is a vexed question in botanical circles. The topic came up in a recent article by an author wanting to remain anonymous to 'protect the guilty' reprinted in the *Native Plants for NSW* quarterly bulletin. But confusion isn't confined to plant people, everyday English can be a minefield of tricky pronunciations causing red faces. For example, picturesque, quay, gunwales, forehead, the list is endless. Word expert David Astle calls these 'gotcha' words. Names for places, people, plants can be even more challenging to pronounce correctly. What about cotoneaster, or Canowindra? (Not to mention the confusion of names from other languages – a case in point being the Gaelic name Catriona).

So what's the correct pronunciation? In botany we love rules, but there are various conventions which can be applied. To start with, there are two factors underlying botanical pronunciation: what classical scholars think ancient Greek and Latin sounded like, and what traditional English pronunciation of those languages is. This involves the sound of certain letters (for example, arkarkia versus aKAYsha for acacia) as well as the stresses in a word.

Usage and other traditions also have a role in determining pronunciation. In some cases, this results in a way of saying a word being recognised even if it doesn't follow a given rule. It is unsurprising to find that we Australians like to buck the system. Imagine pronouncing callistemon callySTEEmon, grevillea GREVillea or hakea HARKeea as rules might dictate.

In the case of the word petrophile, it comes down to where we put the stress or accent, resulting in either three or four syllables. None of the word's component parts refer to botanical structures (which should take the main accent) or a surname (where the stress is usually on the second syllable). We need to look beyond botany to the rules and customs of English language.

The suffix -phile, from the Greek, is often used to coin nouns combining two elements where the second part -phile means 'lover of' or 'enthusiast for' and the first part specifies what is loved. In *Petrophile*, the word means rock-loving. There are hundreds of English words with the same ending, including bibliophile, Francophile, chocophile, oenophile, even plant-related ones like orchidophile, and more scientific terms like acidophile. In all cases the suffix is a single syllable, -PHILE (as in -FILE). Both components usually have equal stress. Following this lead, the pronunciation should be PET-RO-PHILE, three syllables. Although this makes the word components clear and is a pointer to its meaning, petrophiles do not necessarily grow in rocky situations and so as a descriptor for the genus this concept is not very useful.

DID YOU KNOW?

When infused in hot water, the flowers of *P. brevifolia* are said to give off a brilliant yellow colour.

The unfortunate prominence (or overuse) in the media of a similar-sounding term for abnormal or socially unacceptable behaviour (pedophile or paedophile) causes those of us who frequently deal with this genus headaches. The syllables are the same and only a couple of hard-to-hear consonants differ. In speech, there is a high likelihood of mistaking PETroPHILE for PEDoPHILE, especially for listeners unfamiliar with this plant genus. Perhaps if the alternate pronunciation PEEDoPHILE was adopted we might have less of an issue. And the suffix -phile is a little offputting, reminding us of others like -philia, -philiac, -philic or -phobe, which tend to have negative connotations.

The alternative is the four-syllable version pe-TROPH-i-LEE which trips easily off the tongue much like epitome, hyperbole, minestrone, even Penelope. These words sound out all their elements in four syllables, end in the sound -EE, and often place the stress on the second and fourth syllables. The origin of this usage probably goes back into history. For around 160 years this genus was known as *Petrophila*, so pronounced in the same way as the desert-loving genus *Eremophila*. The change to *Petrophile* involves only a minor change of pronunciation to end in -EE instead of -AH. *Alyogyne* is another plant genus often pronounced in this fashion, as in ally-OH-jin-EE.

So, we have two recognised ways to pronounce *Petrophile*. Both are acceptable and widely understood. You can choose to use whichever you prefer. It's a bit like the potayto/potarto, tomayto/tomarto divide in the old song *Let's Call the Whole Thing Off*.

So which do <u>we</u> use? We prefer the pronunciation pe-TROPH-i-LEE which is free of any associations. If you want to ensure you are not misunderstood, we recommend pe-TROPH-i-LEE.

About petrophiles…

Europeans first discovered petrophiles in 1770 when Banks and Solander visited eastern Australia. The German botanists who studied the early specimens were obviously impressed, giving the first species the name pulchella from the Latin meaning small and beautiful. However the horticulturalist Joseph Knight (one of the first to successfully propagate it) was reportedly less convinced, asserting that it has few claims to a place in collections. However, many species went on to be cultivated and admired, especially when some of the spectacular WA species were introduced. Nearly two centuries later horticulturalist Rodger Elliott declared *Petrophile* to be an outstanding member of the family *Proteaceae*, with many beautiful species.

The total number of species recognised in the genus currently stands at 66. Including subspecies (relating to five of the species) the total number of petrophile taxa comes to 73.

Distribution

Petrophiles are mostly found in temperate Australia. A small number of species occur in subtropical and semi-arid areas. As you would expect there are none from the Northern Territory. In the other states we might expect petrophiles to occur in similar places to isopogons, however Victoria and Tasmania have no petrophile species at all, and South Australia has only one species restricted to the discrete area of Kangaroo Island (*P. multisecta*). To the north, Queensland actually has three species, one of which (*P. canescens*) can be found as far north as Gladstone, as well as some distance into the adjacent inland pastoral region. Compare this to WA where species do not extend quite as far north (up to about Shark Bay). Of the eastern states, NSW has the most species with just four. As with most genera the greatest number of species and greatest diversity occurs in southwest WA. Way back in 1870 botanist Bentham summed it up when he described the genus as 'chiefly western'. WA is home to 60 species or over 90 per cent.

Petrophiles are found on the coast and quite a way inland, from sea-level to moderate altitudes. This takes in a range of climates from subtropical to cool (light to moderate frosts).

Most of the western species are found growing in deep sand, in sandplain heaths. Although some are found in gravelly soils, these soils are extremely well drained. The eastern species live more up to their generic name (rock-loving) and are found predominantly in sandstone country, in dry sclerophyll forest or heath. They occur close to the Great Dividing Range and down to the coast while western species are found throughout the South Western botanical zone. Most prefer full sun, but some occur in open forest understorey.

Characteristics

Catriona Bate

Petrophile is a genus of woody evergreen shrubs endemic to Australia. Commonly known as conebushes or coneflowers, prominent flowers are followed by brown/grey conical fruits. The species within the genus vary greatly in their form. They range from prostrate and low, almost ground hugging plants, to medium shrubs up to around three metres high.

The genus as a whole is considered to have excellent potential for cultivation. In fact, species have been cultivated for over two centuries. Tony Cavanagh found that from 1790-1 when *P. pulchella* was raised from seed received from Port Jackson to late in the 19th century, seven petrophiles are recorded growing in the British Isles, many of them to flowering stage. They were not considered hardy enough to survive outdoors so were grown in pots in glasshouses.

The size, naturally dense habit, prominent inflorescences and interesting foliage and fruit make petrophiles a good choice for gardens. They have great ornamental value and can be used as a feature plant in native landscapes or as background plants in larger mixed plantings. Depending on size they could be used as a screen, barrier or informal hedge. While surveying the Cranbourne Special Collections In 1998-99, horticulturalist Rob Cross assessed potential for floriculture and landscape use, and among his recommendations were *P. biternata* and *P. heterophylla*.

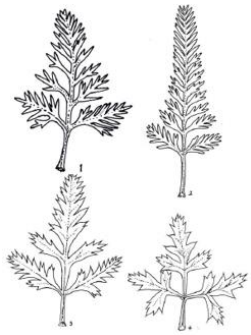
Petrophiles are generally not seen in floriculture today although in 1993 some 300 petrophile stems were reported as being bush picked for export. Many species have terminal flower heads but possibly the stems are not long and straight enough. Unusual and interesting foliage make petrophiles a natural choice for floral arrangements but again stem length could be a factor and perhaps slightly prickly foliage is an issue. Stems last a long time in water – foliage has been reported lasting well in a vase for a month. *P. ericifolia* has been used very effectively in table centrepieces by member Linda HandscombeFoliage of species like *P. sessilis* makes a strong, lacy scaffold in which to place specimen flowers. Spent fruits can be also used in floral decoration.

Little is known about petrophile pollinators, apart from the fact that they are most likely to be insects whose reward is protein-rich pollen. Of the wide range of potential insect pollinators which visit only certain native bee species have been identified as pollination vectors. 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*.

Foliage

Many appreciate petrophiles for their incredibly variable and attractive foliage. Many like the prehistoric feel of petrophile foliage. Leaves can be simple, divided, or multiply divided. They can be flat or terete, glabrous or hirsute. When divided at wide angles there is an intricate three-dimensional effect. In *P. sessilis* relatively even, wide divisions create a vision of angles described as looking like a mass of hexagons. *P. serruriae* and *P. chrysantha* leaves are like starched lace. In contrast, a large number of species have simple, entire leaves (the group known as *Arthrostigma*).

Leaf colour ranges from blue-grey to khaki to dark green to lime green. Unlike hakeas or dryandras the leaves of petrophiles, while often stiff, are rarely highly prickly.



A large proportion of species are named for their leaves. Examples are glauca (meaning bluish-grey), acicularis (needle-like spines), anceps (two-edged), arcuata (arc-like), biloba (twice divided), misturata (mixture of divided and simple leaves), and helicophylla (spirally twisted). *P.diversifolia* is named for its different shaped leaves (juvenile) close to the ground, compared with those at the top of the stems. See Margaret Pieroni's drawing of the different stages, right.

A selection of leaf shapes is provided overleaf. A discussion of the way in which petrophile leaves can change colour can be found in our article in this newsletter.

Top row, L to R: *P.seminuda, P. sessilis, P. biternata, P. chrysantha*. Middle row, L to R: *P. prostrata, P. serruriae, P. linearis, P. ericifolia*. Bottom row, L to R: *P. glauca, P. squamata, P. aculeata, P. helicophylla.*

Flowers

Petrophiles flower prolifically, each inflorescence consisting of hundreds of narrow, tubular flowers packed into cone shaped heads. Flowers are often hairy on the outside. Each is generally borne terminally (sometimes several together) or at the leaf axils. Inflorescences are sometimes so numerous they cover the entire plant, completely hiding leaves.

When the flower opens with the perianth tube splitting into four to reveal the pollen presenter, petrophiles tend to split all the way (whereas isopogons more commonly only split part-way.) The result is distinctive – erect unopened flowers surrounded by a skirt of opened flowers which have coiled back on themselves. After flowers open or are spent, pollen presenters can stay quite erect too. Being held out from the flower head, both style and presenter are a real feature, sometimes giving a 'spiky hairdo' look (see *P. ericifolia*, right).

***P. circinata* has the longest and largest flowers**

Individual petrophile flowers are relatively short at around 10-15 mm. Only a handful of species have flowers measuring 30mm or longer. Examples are *P. circinata* (up to 40mm), *P. helicophylla* and *P. linearis* (up to 35mm) and *P. megalostegia* (up to 30mm).

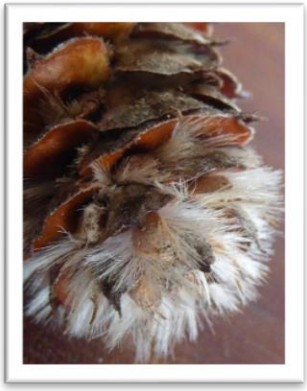
Flower colour is most diverse in western species; within species, the shade and sometimes the hue will also vary. Eastern species all have similar creamy-yellow

colours. The attractive pink-flowering species are only found in WA, and unlike *Isopogon*, only a handful of petrophile species have truly pink flowers and only one, *P. teretifolia*, has bright pink blooms. Closely related species such as P. stricta and P. aspera have paler pink flowers. Many of us have fallen in love with *P. linearis* (Pixie Mops) for its delicate flower colour, described as grey-pink or mauve to almost white. Another species with soft pink colouring is *P. biloba* which is described as ranging from mostly grey to pink with inflorescences spread along the stem in axils. *P. axillaris* (which some may know as a pink form of P. serruriae) also has pale pink colouring. A few species are white or off-white; *P. nivea* is actually named for its pure white flowers.

An overview of flower colours is provided below.

Top row, L to R: *P. prostrata, P.serruriae, P. anceps, P. drummondii*. Middle row, L to R: *P. brevifolia, P. fastigiata, P.glauca, P. nivea*. Bottom row, L to R: *P. teretifolia , P. linearis, P. biloba, P. diversifolia*.

A number of species really stand out especially in the WA bush or kwongan, their vibrant hues ranging from school bus yellow to gold, for example, *P. drummondii, P. chrysantha* and *P. ericifolia*. We have also noticed particularly bright yellows on some plants of *P. serruriae, P. globifera, P. biternata* and *P. seminuda*. In the east the bright yellows are all isopogons.



Fruit

Each individual flower has a small bract that becomes woody after the flower has finished. These thickened scales stay attached to the floral rachis long after the fruit has matured and dispersed. The scales open just enough to release flattened nuts when the plant suffers stress. The

persistent cone scales is the key feature which distinguishes petrophiles from isopogons (in which the cone scales drop with the seed thereby collapsing the entire cone).

These distinctive cones, like small pine cones, are longer than they are wide. *P. shirleyae* is the longest, growing up to 8cm long while *P. pulchella* (left) gets to 6.5cm, *P. macrostachya* to 6.5cm and *P. shuttleworthiana* up to 6cm. The latter's common name candlestick petrophile illustrates its form.

The single-seeded fruit is a small, flat nut that is generally shaped like a heart or oval with long hair around the margins or base. Some species have a tail which comes out of the apex.

History of the genus

Catriona Bate

New Australian species were being named from the 1790s but it took a while for a separate genus for petrophiles to be recognised. Like many genera the story of *Petrophile* evolved over time as Australia was explored and the science of taxonomy developed. A similarity to protea resulted in the generic name *Protea* initially being used for early species like *P. pulchella*. In 1807 Richard Salisbury formally gave the generic name *Atylus* to what later became petrophiles and isopogons, recognising their lack of nectar glands.

Meanwhile Robert Brown had collected many species while sailing around this continent with Matthew Flinders. With access to a range of specimens eventually he decided on a genus he called *Petrophila* from the Greek petra, a rock, and philos, beloved. He perceived a common habit to be rock-loving,

a bit of a misnomer as many species don't actually grow in rocky situations especially in the west. Salisbury immediately adopted Brown's approach, quickly inserting the new names into his friend Knight's paper on the cultivation of proteaceae – but changing *Petrophila* to *Petrophile* (possibly a spelling error on his part). In doing so he beat Brown into print; Knight published in 1809 and Brown in 1810. The genus name *Petrophile* is now formally attributed as Robert Brown ex Knight (or R. Br. ex Knight).

Most botanists subsequently followed Brown's treatment although as late as 1891 Kuntze tried to revive *Atylus* on the grounds of priority. The issue was resolved with international agreement to use Brown's approach in 1905. *Petrophila* as proposed by Brown was widely used up until about 1970 when the priority of the name *Petrophile* was recognised (although this decision was not formally documented). All species described before 1990 were originally ascribed to *Petrophila*.

Petrophile continued to be considered to be most closely related genus to *Isopogon*. For example, Bentham's 1870 description of each genus lists similar species in the other genus. The landmark classification of *Proteaceae* by Johnson & Briggs in 1975 placed *Petrophile* and *Isopogon* together in subtribe *Petrophilinae* within *Proteoideae*. The attribution of some species has been problematic and over time some have moved between the two genera. An example is the species now known as *Isopogon dubius* (its name, from the Latin, refers to the uncertainty regarding its generic classification). Brown classed it as P*etrophile* but later botanists as *Isopogon* and the matter was not resolved until 1917. More recently (2007) Cranfield and Macfarlane noted a similar ambiguity in the generic placement of a new species, *P. vana*.

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 & Barker based on DNA. Within *Proteoideae*, *Petrophile* was placed in a new tribe, *Petrophileae*. (*Isopogon* was

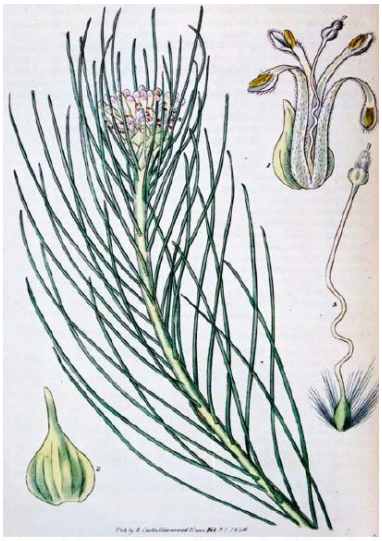
instead placed with A*denanthos* in *Leucadendreae*.) As DNA analysis continues to develop into the future, it will be interesting to see if this treatment stands.

Through the 19th Century and beyond, botanists like Endlicher, Meisner and Bentham continued to revise the genus. The only comprehensive modern taxonomic update was by Don Foreman in 1995. Between 2005 and 2011, Hislop & Rye (with Shepherd and Hollister) updated the key for WA members of the genus. Although historically botanists have attempted to further classify the genus into sections there is no current infrageneric classification and old classifications of sections are not well defined. An exception is section *Arthrostigma* which includes a large number of WA species and was updated by Hislop & Rye in 2005.

Petrophile naming

Catriona Bate

The story of species discovery and formal description is a long one. The first species to receive scientific attention was the eastern species *P. pulchella*. In 1796, German botanists Schrader & Wendland named it *Protea pulchella*, while English botanist Salisbury named it *Protea fucifolia* in the same year. In 1810 Robert Brown identified it as belonging to a separate genus (*Petrophila*) and described another species, *P. pedunculata*. The other two common eastern species (*P. sessilis* and *P. canescens*) were described in 1827 and 1830 respectively. It was not until the second half of the 19th Century that the two remaining eastern species, more far-flung and less common, were formally described (*P. multisecta* from Kangaroo Island in 1868, and *P. shirleyae* from Queensland in 1891).



Petrophile acicularis Curtis' Botanical Magazine 3469, 1836

Brown was the first to describe the spectacular western species, becoming a specialist in the subject and ultimately the largest single contributor to current petrophile taxonomy. Following his sea expedition around Australia with Flinders in 1801-03 he described seven western species (published 1810), including the beautiful species *P. teretifolia*, the first recorded pink flowered species, and well-known species *P. squamata* and *P. diversifolia*. He later named new western petrophile specimens from land expeditions by William Baxter and Charles Fraser, leading to twelve new species described in 1830. This bounty included highly prized species such as *P. linearis* (Pixie Mops), *P. biloba* and *P. serruriae*.

The next major chapter in the discovery of petrophile species was contributed by James Drummond, an emigrant to the new Swan River colony. Over twenty years he travelled long distances amassing a vast collection of new plants which he sold to overseas botanists. They ended up in herbaria all over Europe including Switzerland where botanist Carl Meisner (or Meissner) took a special interest in proteaceae, becoming an expert in petrophiles among others such as dryandra. He named eleven new petrophile species from Drummond's material, published from 1845 to 1856, including one he named for this prolific collector (*P. drummondii*, 1845). Drummond's material was also used by botanists Lindley (*P. seminuda* and *P. heterophylla*, 1840) and Mueller (*P. megalostegia*, 1876).

Botanists continued to study petrophile species through the 19th Century and into the next however little of this work has left its mark on modern taxonomy. An example is Michel Gandoger (1850–1926). Peter Olde's article below shows that some of his work may in fact be useful. The next species discovered and still current is the western species *P. incurvata*, described in 1912 by Fitzgerald. It wasn't until the 1980s that the current record shows new activity occurring on *Petrophile* by Don Foreman who was a proteaceae expert but had previously concentrated on other genera. His work resulted in a revision of the genus (published in 1995 in Vol. 16 of *Flora of Australia*). He described a total of fourteen new western species, including the common and

highly recognisable species *P. glauca* (described by Elliott and Jones as 'a delightful species with attractive foliage and flowers') and *P. helicophylla* with its lovely corkscrew leaves.

Poor health limited Foreman's work and he did not complete his studies of the genus (he died in 2004). Further work on the *P. brevifolia* complex was done in the 1980s in an honours project by Natalie Murdoch at the University of Western Australia using information on habit, habitat and, molecular sequencing, flowering time differences as well as morphology to help determine how many species etc. should be recognised in that difficult group. In the 21st Century botanists began to tidy up loose ends. WA botanists Mike Hislop and Barbara Rye began a program of updates, describing three new early flowering species in 2002, then in 2005 publishing a major revision of one large WA section (*Arthrostigma*) with five new taxa and two reinstated species. This included a species named for Foreman in recognition of his contribution to the genus (*P. foremanii*). Others described new species in 2007 (*P. vana* from Mt Magnet by Cranfield & Macfarlane) and 2010 (*P. latericola*, previously thought to be *P. brevifolia*, by Greg Keighery). In 2011, three new species were described and one reinstated (*P. axillaris*) in a paper by Rye, Hislop, Shepherd and Hollister.

However, there is still much taxonomic work to be done which may result in splitting and new species. There are several areas needing attention already flagged by botanists, such as variants of *P. crispata, P. seminuda, P. squamata* and *P. brevifolia*. In addition, Foreman noted that *P. serruriae* is somewhat variable and needs further study, an example being a population of *P. serruriae* from the Whicher Scarp near Busselton. In this newsletter Peter Olde raises additional candidates such as *P. biloba* and possibly *P. striata*. His investigation so far also reveals a lack of properly identified type specimens for the earliest species. Finally, serial revisions have reduced the utility of Foreman's 1995 key and so an updated overall key is sorely needed.

Petrophile and Abbé Michel Gandoger

Peter M. Olde

Michel Gandoger was born in Arnas, Rhone. He gathered the first of the 80,000 specimens he ultimately collected over a lifetime and now stored at LY (Lyons, France) at age 15. At age 21 he joined the Botanical Society of France, remaining a member his whole life. He became a priest at the age of 26 but appears to have spent his whole life as a botanist, his career prolific with publications.

Gandoger, a super splitter, does not enjoy a good reputation among botanists. He believed that infrapopulational variation was stable and no matter how little a specimen varied one from another, it deserved the rank of species. His failure to understand that species occur in populations that exchange genes and therefore vary, resulted from his horticultural experiments in which he grew from seed (probably selfed) seedlings that did not vary from their parents, some for up to 15 generations. He reasoned that this could be inferred across all genera for the next 15 generations and beyond, including those he had not tested (e.g. Australian plants). His idea was that the plant kingdom consisted only of myriads of distinct, invariant species. The result was a proliferation of published names that mostly ended in synonymy. From at least 1968, Don McGillivray made a detailed study of Gandoger's Australian names which he published in 1973 in the journal *Contributions from the N.S.W. National Herbarium*, the journal which preceded *Telopea,* one of their current journals.

In 1919, Gandoger described 69 species in the Proteaceae. New species were described in the genera *Conospermum* (5), *Dryandra* (2), *Grevillea* (11), *Hakea* (13), *Isopogon* (8), *Lambertia* (2), *Lomatia* (5), *Persoonia* (15) and *Petrophile* (6). Gandoger advanced characters in a key-like format. He recognised relationships with other species but did not accept they were the same, often splitting them up according to his botanical philosophy. McGillivray (1973) noted that some of Gandoger's observations on morphological characters of Australian plants are 'incorrect and superficial' but praised him as a master in the formation of specific epithets. McGillivray also noted that, out of the 212 Australian names Gandoger published, only two have

been accepted. That was 1973. Subsequently, in the genus *Grevillea,* three of his species (*G. patulifolia, G. neurophylla, G. alpivaga*) are accepted and one about to be (*G. scabrifolia*) and one possibly (*G. glaucina*). One *Persoonia (P. recedens)* is now accepted. *Hakea laevipes Gand*. is accepted in that genus. *Banksia sessilis* var. *cygnorum* (Gand.) A.R.Mast & K.R.Thiele is a Gandoger name accepted at varietal level. At this point of time, none of his species in *Isopogon* or *Petrophile* have been recognised at any level.

In order to study Australian plants, Gandoger advertised or personally wrote to numerous Australian botanists and botanical institutions requesting specimens. The greatest respondent to these requests was Joseph Maiden who reportedly sent him some 1600 specimens from the New South Wales Herbarium between December 1898 probably up to March 1903. Many of the specimens sent came from remote areas and a wide diaspora of collectors, such as the seed collector Herbert J. Rumsey (1866–1956) and the Conjola forester, W. Heron (fl. 1898–1920). According to J.H. Willis, the National Herbarium of Victoria sent him 100 specimens, 50 in May 1909 and 50 more in July 1911. Willis mentioned that no duplicates of specimens regularly cited by Gandoger and collected by Charles Walter (1831–1907) were retained. However, McGillivray has suggested that Walter, who had his own private herbarium, may have dealt directly with him. An unknown number were sent from Western Australia by Alexander Morrison, who was then in charge of the Western Australian Department of Agriculture. Other individual botanists, such as Max Koch (1854–1925) also supplied specimens. McGillivray (1973) gives a detailed list of the collectors of Gandoger types and some biographical notes and references.

I was wondering about *Isopogon* and *Petrophile* because Gandoger's species names fall into a special category. Although Gandoger had faulty reasoning about what constitutes a species, and his descriptions often fall well short of important diagnostic features, many of the specimens he received were from then recently discovered, sometimes unknown, populations. The point to make about Gandoger is that, although he was not greatly insightful as a taxonomist, he operated in an era when the taxonomy of Australian flora was in its infancy. In a sense, the shotgun approach he adopted was sure to hit some targets recognised later as significant and for which his name has priority. For instance, his specimen of *Grevillea patulifolia* was collected at Barber's Creek, a locality that has since changed its name to Tallong. Neither before nor after has it subsequently been collected at that locality. Gandoger gave it a short Latin description without any serious diagnostic value. The point is, when closely examined, the specimen had other morphological and ecological characteristics that we were able to link across numerous other populations in the southern highlands and into southern Sydney. Despite Gandoger's inadequate description, his type specimen was from among this group.

DID YOU KNOW?

Only 5 species were named for people: *Petrophiles shuttleworthiana, drummondii, shirleyae, merrallii* and *foremanii*. They were all botanists or collectors of type specimens. *P. serruriae* is named for its similarities to a South African genus named for a botanist.

The species of *Petrophile* he split up were *P. biloba, P. pedunculata* and *P. striata*. Gandoger described the following species which are dealt with more fully below: *Petrophile argyrotricha, P. bakeriana, P. chrysotricha, P. dasyclada, P. obtusifida* and *P. stylaris*. Most involved discriminations based on minute characters that may or may not be relevant on a whole of species examination. The specimen of ***Petrophile chrysotricha*** Gandoger is of special interest.

1. ***Petrophile argyrotricha*** Gandoger*, Bull. Soc. Bot. France* LXVI 226 (1919), as 'Petrophila argyrotricha'.
Current status. A synonym of ***P. biloba*** R.Br.
Description. Rami virides, glabrescentes, phylla involucri latiuscula, ovato-acuta, corollae 18–22 mm longae, pili albi patuli.
Trans. Branches green, glabrescent; involucral leaves broadish, ovate-acute; corolla 18–22 mm long, the hairs white, spreading at around 90º.

HOLOTYPE: Western Australia, Greenmount, Darling Range. *A. Morrison s.n.* Aug. 1897 ex Hb. Morrison (LY). A specimen collected by *Helms* (NSW75981) is a possible isotype (*fide* McGillivray 1973: 350).
Etymology. From the Greek *argyro* - silver, *trichion*' a small hair, alluding to the hair colour on the flowers.
Comment. It is unlikely that Gandoger ever compared his specimen with the type specimen, though he may have read Brown's original, short description in the *Prodromus* (1810c) or Bentham's in *Flora Australiensis* (1870). Foreman (1995), following D.J. McGillivray (1973) (not L.A.S. Johnson and McGillivray as cited in his treatment) treated *P. argyrotricha* as a synonym of *P. biloba*. Familiarisation with the variation in this species is warranted before a full, final assessment can be made. Whether Morrison co-collected with Helms is uncertain. It is possible that he incorporated Helms' collection as his own. See also *P. stylaris* q.v.

2. ***Petrophile chrysotricha*** Gandoger*, Bull. Soc. Bot. France* LXVI 226 (1919), as 'Petrophila chrysotricha'.
Current status. A synonym of ***P. biloba*** R.Br.
Description*. Rami novelli albido-tomentelli, phylla involucri lanceolata, tenua, corollae 12 mm longae, pili aurei adscendentes.*
Trans. Branchlets white-tomentose, involucral leaves lanceolate, thin; corolla 12 mm long, the hairs golden, ascending.
HOLOTYPE: Western Australia. 1850. *Drummond s.n.* (LY ex MEL).
Etymology. From the Greek *chryso* - golden, *trichion*' a small hair, alluding to the hair colour on the flowers.
Comment. Gandoger (1919: 227) clearly recognised that there was a relationship with *P. biloba*, and suggested that his two species be placed near it. Foreman (1995) has interpreted McGillivray (1973) incorrectly (also again incorrectly citing Johnson and McGillivray), and transferred *P. chrysotricha* to synonymy under *P. biloba*. McGillivray (1973) actually wrote '*P (?) biloba*, approaching *P. propinqua* [now included in *P. squamata*]. The flowers of this specimen show a greater resemblance to those of *P. propinqua'* than is usual.'

Gandoger's specimen was sent from MEL where Drummond's key collection was held. This collection needs much more attention and suggests the need for a close revision of *P. biloba* and *P.propinqua (*now included in *P. squamata),* by which is meant a close examination of all the specimens held in Australian herbaria of these two species and field study. Drummond gave no locality data, and there is apparently no duplicate at MEL (which is amazing in itself). I am puzzled that they sent a Drummond specimen without a duplicate being retained. McGillivray gives the collection date as 1880 but I think it was 1850, coinciding with Drummond's 6th collection, i.e. to the north of Perth.

DID YOU KNOW?

Honey possums, dusky honeyeaters and gang-gangs have been seen feeding on petrophiles. But only native bees are known to pollinate them.

3. ***Petrophile bakeriana*** Gandoger*, Bull. Soc. Bot. France* LXVI 226 (1919), as 'Petrophila bakersana'.
Current status. A synonym of ***P. pedunculata*** R.Br.
Description*. Fidi secundarii acuto-mucronati, 8–10 mm longi, squamae fructiferae cuspidatae.*
Trans. Secondary lobes acute-mucronate, 8–10 mm long, the fruit-bearing bracts bearing a sharp firm point.
HOLOTYPE*:* New South Wales, Picton, Nov. 1896, *R.J. Baker s.n*. (LY ex Technological Museum, Sydney)
Etymology. The epithet honours Richard Thomas Baker (1854–1941) curator of the Technological Museum whose collections are now incorporated in the NSW herbarium. According to McGillivray (1973: 350) Gandoger attributed to Baker some of the collections made by William Bauerlen, the Museum's collector.
Comment. Do plants from the Picton area show special variation at the population level?

4. ***Petrophile obtusifida*** Gandoger*, Bull. Soc. Bot. France* LXVI 226 (1919), as 'Petrophila obtusifida'.
Current status. A synonym of ***P. pedunculata*** R.Br.
Description*. Fidi secundarii obtusi, 3–4 mm longi, squamae fructiferae vix mucronatae.*
Trans. Secondary lobes obtuse, 3–4 mm long, the fruit-bearing bracts scarcely mucronate.
SYNTYPES*:* New South Wales, Wingello, *Maiden!*, *Boorman*!, *Walter*!
Lectotype (*fide* McGillivray 1973: 351) Wingello, Dec. 1899, [*Boorman*] (LY ex Hb Chas. Walter).
Isolectotypes New South Wales, Wingello, Dec. 1899, *Boorman* (Boorman! Maiden!) (LY ex NSW); Wingello, Dec. 1899, *J.L. Boorman s.n.* (NSW76143).

Etymology. The specific epithet is derived from Latin – *obtusus*, obtuse, *fidum*, lobe, a reference to the obtuse leaf lobes.
Comment. The lectotype and isolectotypes were all collected by John L. Boorman (1864–1938). The specimen from Charles Walters Herbarium was not collected by Walters. It had been collected by Boorman and sent to Walters on exchange by the Botanic Gardens, Sydney. Walters forwarded the exchange specimen to Gandoger. The Boorman specimen forwarded by Maiden has been confused by nominating Maiden as collector. There is also a duplicate at NSW. McGillivray (1993: 351) noted this as 'an unsual example of typal nomenclature'.

5. ***Petrophile dasyclada*** Gandoger*, Bull. Soc. Bot. France* LXVI 226 (1919), as 'Petrophila dasyclada'.
Current status. A synonym of ***P. striata*** R.Br.
Description. *Rami dense et breviter tomentosi, phylla involucri superiora obtusa, styli inclusi aut fere inclusi.*
Trans. Branches densely and shortly tomentose, the upper involucral leaves obtuse, the styles [tips of the tepals] enclosed or almost so.
HOLOTYPE: Western Australia, Woorooloo, Sep. 1907, *M. Koch* (LY).
ISOTYPE: 'Woorooloo, Sep. 1907, *M. Koch 1477* (MEL673405).
Etymology. The epithet is derived from the Greek *dasy*– hairy, *clados* branch, a reference to the branchlet indumentum.
Comment. The relevance of these characters can only be assessed by a revision of *Petrophile striata*, involving an examination of all the specimens held of this species and a study of the species in the field.

6. ***Petrophile stylaris*** Gandoger*, Bull. Soc. Bot. France* LXVI 226 (1919), as 'Petrophila stylaris'.
Current status. A synonym of ***P. striata*** R.Br.
Description. *Rami sparse et longe pilosi, phylla involucri superiora acuta, styli exserti.*
Trans. Branches sparsely pilose with long hairs, the upper involucral leaves acute, the styles [tips of the tepals] exserted.
HOLOTYPE: Western Australia. Kelmscott, Canning River, Sep. 1898, *A. Morrison s.n.* (LY ex Hb Morrison) – specimen marked B at right of sheet.
Etymology. The epithet is derived from the Latin *stylaris* – relating to the style, a reference in this case to the exserted tips of the tepals which Gandoger called 'styli'.
Comment. There are two specimens mounted on the type sheet, both collected at the same locality at the same time by different collectors, (who may actually have collected them in company). The specimen marked 'A' at left was collected by *Richard Helms* (1842–1914), botanical collector. There is a duplicate at NSW (NSW76006). Neither of these specimens are types. However, it is interesting to compare them with the type collected by Morrison at the same locality, clearly from a different plant.

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Solving the mystery of eastern petrophiles

Phil Trickett

It has always amazed us that the vast majority of our most knowledgeable and experienced native plant enthusiasts can't tell one petrophile from another. This is most noticeable in our own backyard where we only have five species across NSW, Vic and Qld. Surely petrophiles aren't that uninteresting. So let's have a look at our eastern petrophiles and see if we can give you some tips on how to tell them apart. The five eastern species are:

P. pulchella – grows along the coast and adjacent ranges from SE Queensland south to Ulladulla in NSW.
P. sessilis – often grows with *P. pulchella* but is more confined to the coast and adjacent ranges between the central coast of NSW and just south of Ulladulla.
P. pedunculata – also found growing in similar areas to *P. sessilis*.
P. canescens – found mainly on the ranges of NSW north from near Nerriga in the Morton National Park through to Blackdown Tableland and Carnarvon Gorge in Queensland. Is also found in coastal health on the NSW Central and North Coast.
P. shirleyae – commonly found growing in the south-eastern coastal areas of Qld. Mt Emu just north of Coolum Beach is a good location to find this species.

Often two or more of *P. pulchella*, *P. sessilis* and *P. pedunculata* can be found growing together. Examples of such locations include the Tianjara Falls lookout near Nerriga, and the South Pacific Heathland Reserve at Ulladulla.

Despite all the eastern species having divided leaves, the easiest way to separate these species is actually by their leaf structure. This differs markedly for *P. pulchella, P. sessilis* and *P. pedunculata* (see photo below), the species most often found near each other. *P. pedunculata* leaves are almost double the length (up to 18cm) of the other species and are distinctively structured on a rather flat two-dimensional plane compared to the strongly three-dimensional form of the other four species. *P.sessilis* is easily recognised by its often right-angle two-three times divaricate (widely spreading) leaves which are stiffer and more prickly than the other species. The leaves of *P. pulchella* diverge into upright segments up to three times at angles of around 30-45 degrees.

Left, *P. pulchella*; Middle, *P. sessilis*; Right, *P.pedunculata*

The leaf structure of *P. shirleyae* is similar to that of *P. pulchella*, but *P. shirleyae* is a small multi-stemmed shrub with a lignotuber whereas P. *pulchella* is a tall single stemmed shrub with no lignotuber. Finally, *P canescens* can be identified by its pinnate (like a feather) leaves with the pinnae further divided one or two

times. *P. canescens* leaves are typically grey and hairy, in contrast to the green, glabrous leaves of the other species.

Sometimes it isn't that easy! Despite the marked differences as outlined above between the five species, intergrades or hybrids are common where more than one species co-exists. We have seen intergrades at Jervis Bay between *P. pulchella* and *P. sessilis*, and there are reported intergrades/hybrids between *P. pedunculata* and *P. pulchella* in various locations. So please keep an eye out for any of these possible intergrades/hybrids and report back to us.

Finally the prominent peduncle or stalk on the fruit of *P. pedunculata* is often cited as a defining characteristic. However, other species with a peduncle are *P. shirleyae* and *P. pulchella* which have some fruit with a peduncle and some without.

How to grow petrophiles

Phil Trickett

Petrophiles are generally considered harder to grow than isopogons. We have all experienced sudden deaths. However, Wrigley & Fagg have described them as hardy and some of our members find petrophiles to be a little hardier than isopogons, or more robust once established. Conditions required are generally similar to those for isopogons. Like all proteaceae, the WA species are vulnerable to *Phytophthora cinnamomi*, the root rotting fungus. Grafting will eventually become the way to successfully grow fussy petrophile species in our gardens.

A range of species is grown by members, mainly reflecting availability. However, the majority of species have never been seen in cultivation and this is what our Study Group needs to address.

Most species require good drainage and many cope with dry conditions. During the millennium drought our members reported remarkable resilience from petrophiles in their gardens although watering was needed. Some species may be tolerant of wetter conditions (e.g. *P. shirleyae*) but we need to find out more about this aspect of cultivation in petrophiles.

Some species cope with cold conditions too. Members living in severely frost-prone areas have had success with selected species: Robbie Blackhall-Miles in Wales, UK grows *P. canescens*, and in Armidale, NSW John Nevin has eight species – *sessilis, fastigiata, longifolia (probably filifolia), scabriuscula, canescens, ericifolia, biloba* and *plumosa*. John reports that he has tried many other species over the years that could not take the extreme cold. Elliott & Jones suggest the following species will also withstand up to -4°C (moderate frost): *linearis, filifolia, pedunculata, pulchella, seminuda, squamata*, and *teretifolia*. Most species will cope with up to -2°C (light frost) for short periods – young growth may be damaged, but plants will reshoot.

When looking at the successful cultivation of petrophiles in our gardens, like most Australian genera we need to separately deal with eastern and western species. The eastern species are far hardier to a range of conditions

DID YOU KNOW?

P. pulchella, 'the beautiful petrophile', is the trailblazer of the genus. It was the first to be discovered by Europeans, the first to be collected and described – all before 1800 – and is the type species for the genus. One of the toughest in cultivation, it was also the first to be propagated from seed (1790) and from cuttings (1809).

compared to those from Western Australia which can be very difficult to maintain outside their home conditions. Even WA members report difficulty growing local species in their gardens, so they definitely need optimum conditions!

Eastern species

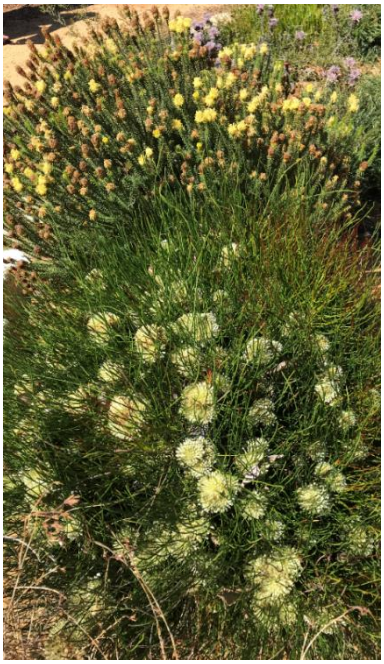
P. sessilis, *P. pulchella* and *P. shirleyae* are all tough, adaptable species which have proven long-lived in cultivation provided reasonable drainage is provided. *P. shirleyae* comes from SE Queensland with its high summer rainfall and is very happy in our permanently moist soils and even appears to tolerate occasional water-logging. However, in summer-dry Mediterranean climates, supplementary watering through the dry summers is recommended to mimic its home conditions. In contrast, *P. sessilis* and *P. pulchella* appear to be tolerant of dry summers based on examples thriving in southern Victorian gardens. However, given the increasingly severe hot, dry summers in recent years, supplementary watering is recommended for all eastern species.

Not much is documented regarding cultivation requirements for *P. canescens*, but mostly it comes from drier habitats than *P. sessilis*, *P. pulchella* and *P. shirleyae*. This implies that it might require better drainage than the other three species and is probably more tolerant of dry summers and cold winters.

P. pedunculata is an attractive species, especially when pruned, but we have found it short-lived in our rich, moist soils. It appears to require better drainage than we can provide but is worth growing in raised/sloping beds.

Western species

Excellent drainage is vital to the successful cultivation of petrophiles from Western Australia. In our summer-wet high rainfall garden on the NSW South Coast, we have rarely been able to encourage more than six months out of WA species. Like many other proteaceae, western petrophiles are extremely sensitive to phytophthora. The wet summers of the east coast promotes the growth of this fungus and explains one of the reasons for the difficulty cultivating WA species. Yet just a little further south, Mark and Carolyn Noake are having great success with *P. teretifolia* and *P. biloba* by planting on a sloping bank of a dam which ensures that water never pools around the roots. These species are widely grown in our group and seem to be the toughest species on their own roots.



***P. ericifolia* and *P. filifolia* growing in a garden in deep sand**

So raised garden beds and free-draining soils appear essential to growing these touchy WA species. However, in summer-dry inland and southern regions of Australia, excellent drainage is not as vital. But, given the incredibly dry, hot summers experienced in inland NSW, Victoria and South Australia in recent years (notably this year where many areas have experienced less than 20mm in the first three months), drip irrigation is crucial to prevent losses. Even fully established plants struggle to withstand these conditions without supplementary watering. Drip irrigation is a very effective watering strategy, ensuring that water gets deep into the bottom of the root system.

Members' experiences

Marilyn Sprague from Bendigo, Vic. successfully grows *P. biloba*, which survives with no watering in a dry semi shaded position – 'I love the flowers. I also have *P. squamata* and *P fastigiata*, well drained in that rainfall runs off compacted clay. Planted under other vegetation, acid soil - Ph 6, no pests and diseases or fertilisers.' **Mark & Carolyn Noake, Moruya NSW** have had a great run growing eastern petrophiles and are branching out into the trickier WA species – **'**Those plants that have survived propagation have gone on to be robust. *P.*

pulchella and *P. sessilis* have rewarded our patience with 10 years of quite stunning floral displays. *P. teretifolia* and *P. biloba* have also established well in our garden, flowering profusely and needing little attention in harsh, dry conditions (*by South Coast standards! Ed*.). Important factors in our success are drainage, sunshine, sandy soil, eucalypt mulch, only watered in extreme dry spells. Our ph is 5.5. I feel that air circulation is important. We have just lost 1 x *P. sessilis* after about 10 years. I think it might have been root disturbance from my weeding sorrel. Petrophiles seem more robust once they are established. We've lost several isopogons but not many petrophiles in our conditions. We never fertilise but we do find that pruning encourages new growth and thicker foliage density.'

DID YOU KNOW?

A famous botanical dispute from 1809 lives on in the genus name. Only 50 years ago, it changed from *Petrophila*, the name it was given by Brown, to *Petrophile,* a name it was given by Salisbury who reportedly copied Brown's work and published first. Apparently, Brown did not play fair either, refusing to share any of his specimens.

Fiona Johnson, Blayney NSW – '*P. longifolia* (probably *filifolia*, ed.) and *P. sessilis* appear well established and have flowered well. I also have *P. biloba* and *linearis* but they have only been in the ground about six months and haven't been through a winter yet, although they are looking fine so far. They are all in relatively sheltered positions with half day sun and reasonable drainage. After the first few weeks or months, they only get watered by rain. A grafted *P. serruriae* was grown in a pot but never looked happy and was eventually removed. Perhaps just too cold here.'

Paul Kennedy reports successfully growing *P. l*ongifolia (probably *filifolia*), *divaricata, squamata*, *serruriae* and *seminuda* through the millennium drought on his old garden at Strathmerton in northern Victoria, all on deep sand and watered weekly over summer. Paul estimates that these were all at least ten years old.

Rhonda Daniels, Sydney has grown the two local species *P. sessilis and P. pulchella* – 'They are pretty hardy. Suited to a narrow space between fence and path. They can get a bit woody, so always pruning off twigs and sticks. Maybe some fertiliser would have increased the flowers.'

Royce & Jeanne Raleigh, Grampians Vic grow *P. biloba, fastigiata*, and *pulchella* which are now mature, old plants. – 'They have good drainage on raised beds with plenty of sun but a little water through our long dry summers. Have tried very few other species and they succumbed early on. Very difficult to find new species. In our experience Petrophiles are a little hardier than Isopogons. Light pruning in our situation as they are relatively slow growing, because of our long dry spells.'

Alex George, Kardinya, WA has two reluctant to flower petrophiles in his garden **–** '*P. seminuda* – after the first summer, no summer water; flowers occasionally; 12 years old. *P. heterophylla* ditto; vigorous but it has flowered only once in 12 years. More difficult - *P. circinata*, *P. linearis* Reason unknown. May have been weak plants (both ex nurseries). I use no fertiliser or mulch etc., as they do not receive these in the wild. With age, as litter builds up, I often remove it to prevent the basal parts of plants being smothered and to allow better penetration of rain.'

Margaret Pieroni, Denmark, south coast WA successfully grew *P. filifolia, P. helicophylla, and P. biloba* in sand, in her old Perth garden. She found *P. linearis* difficult in Perth even though it was local. 'I am currently growing *P. diversifolia* which grows naturally on my property in Denmark. It is short-lived but self-seeds readily. The few species I have grown have not survived for long and *P. diversifolia* lives fast and dies young!'

Alan Carr, SE Qld is showing great patriotism by growing the local *Petrophile shirleyae* – 'I have had one in the ground and one in a pot for 2 years. (The one in the pot is growing best). Needs regular watering, good drainage and full to part sun. There are two Queensland species and I'm growing one of them. Perhaps I should try to grow *P. canescens* too'.

Miriam Ford, Hurstbridge, Vic is growing *P pedunculata* which is currently in bud on a mound in mostly full sunshine – 'I have been watering once – twice per week in the long dry hot summer we have been having. Fertilising? Probably but sparing I suspect although could depend on what you use. I think some of the formulations (Gro Max or Macrocote) that include some of the other microbiota to help roots access nutrients might assist. I have been using Macrocote in potting mix for tubes & when I plant out into garden. However

re. fertilizer, using little to none used to be said for other Proteaceae such as Grevilleas and now the experts such as Neil Marriott and Max McDowell say one should fertilize regularly with Bush Tucker or other good native mix – much better flowering etc. I throw Bush Tucker on the raised mound.'

Liesbeth Uijtewaal grows all her plants in pots in Holland so her advice on growing Australian natives in pots is invaluable – 'My *P. linearis* is budding up profusely for the first time now! There's almost 50 on the one plant which is rather amazing. Growing *P. ericifolia, fastigiata, linearis, pedunculata, pulchella/sessilis* (not sure which species it is exactly), *teretifolia*. I've grown all species mentioned above equally successfully. I use my 'standard' potting mix for Australian natives and add some extra drainage for young plants. Important: careful watering, not too much not too little, pH is around 5, they're kept relatively dark and humid in winter (glasshouse), part shade in summer. Petrophiles in pots do require fertilization. No pruning needed so far but then the plants are fairly young, the oldest ones, *P. linearis*, date back to Nov 2015. I will prune them eventually to keep them compact.'

Robbie Blackhall-Miles, Wales grows *P. canescens* successfully in the ground. Difficulty in obtaining material is preventing Robbie growing more species.

Tips for successful cultivation

- Grow in free-draining soil
- Water through first summer, water sparingly after that
- Grow as understorey plants in regions with hot, dry summers to provide protection
- Grow WA species in mounded beds to ensure water never pools around roots
- Do not overwater WA species in summer
- Grow in pots but give careful attention to watering, fertilizing
- Grow grafted plants - the development of grafted plants is necessary to increase availability and demand for a range of petrophiles

How to propagate petrophiles

Phil Trickett

While much success has been achieved by the study group in propagating isopogons, mainly via cuttings and grafting, the propagation of petrophiles is proving much more difficult. Most of the problem is caused by petrophiles being very stubborn or slow to reliably strike roots. This impacts not only on restricting success in producing cutting-grown plants but also limits grafting trials due to the difficulty in producing petrophile rootstocks.

We will now examine the state of play in propagating petrophiles, incorporating the experiences and tips of study group members for each of the three means of propagation - seed, cuttings and grafting. Note that detailed information on propagation methods by these three means is available in Newsletter 18 that this article will not repeat.

Seed

Overall, members have found propagating petrophiles from seed is easier than for isopogons but there has still been mixed success. Petrophiles seem to produce considerably more viable seed than isopogons and the seed is easier to extract and locate. However, many report slow growth rates once germinated.

A year ago, Mark Noake reported a remarkable difference in progress of tubestock of the same species (*P. pedunculata*) propagated by seed versus cuttings. His photo (right) shows the result, the seed-grown specimen on the right much smaller despite a head start of three months.

Fresh seed is often considered vital in germinating petrophiles, and this theory is given added weight by studies which have shown that the highest viability of seed in *P. sessilis* at least is from the youngest cones. This implies that the viability of cones declines with age. We'll continue to test this theory. Storage conditions of old seed may be important. One of our members, Paul Kennedy has been given a batch of old petrophile seed and will undertake a trial to check germination rates. Royce & Jeanne Raleigh are testing their old seed too and I also have a batch of old seed that I purchased more than ten years ago plus old Study Group seed, so I'll try to germinate these and report back in the next issue.

Given that it appears that the cones with the most viable seed comes from the youngest cones, collect the youngest cones that are ripe. Cones are ripe when the green scales on a cone change colour to brown/grey. Once cones are removed from the bush, the cone scales will dry out and open over a couple of weeks to enable the hairy seed to fall out or be extracted – tweezers work well to pull seed by its hairs from each cone scale (one flattened seed in each). If you are in a hurry, you can force the cone scales to open by placing freshly picked cones into an oven on 120°C for an hour. Sometimes cone scales open on the plant (see right) so grab the cone before the seed floats away.

Trials of a wide range of pre-germination treatments such as smoke-water, pre-soaking, even singeing hairs or slitting seed have not demonstrated any clear benefits in the history of the Study Group. For example Margaret Pieroni has tried burning dry leaves over the top of newly sown seed with inconclusive results. So once the seeds are extracted you can either test seeds for viability using one of the methods outlined below by Liesbeth Uijtewaal and David Lightfoot, or simply plant them out and take your chances.

Members' tips

Mike Beamish, Vic – 'Freshness of seed seems important. *P. pulchella* sown 6/2/2019 germinated in late March, so about 6 weeks. Not yet potted up, still cotyledons only. About 35 seedlings from over 200 seeds sown of fresh seed. Older seed collected from the same parent 6 months earlier and over 12 months earlier, sown at the same time in early February and positioned nearby (in the open air with dappled shade) have shown no sign of germination.'

Royce and Jeanne Raleigh, Vic report a surprising success story with old seed, stored in air-tight containers – 'When we collected seed many years ago, I purchased hundreds of little clear plastic Amcal plastic pill containers with screw top lids. They were airtight and no moisture could get into the seed. These containers were stored in the house in a relatively constant temperature. Our daughter Ruth was looking at these one day, some years ago, and picked out a Petrophile, not sure what species, and she decided to plant it. We estimated that the seed was at least 14-15 years old. The original germination was very good, but unfortunately we lost many in the potting up, but kept some alive. However we eventually lost the plants that we put into the garden. We have recently found some more seed still in their plastic containers, so Jeanne has just planted some and we will keep you posted re. any results.'

Mark Noake, NSW has just had very encouraging results from his seed raising experiment – 'My one attempt at seed propagation (*P. pedunculata*) was successful with close to 100% germination of fresh seed using the "bog" method. About 25 fresh seeds were sprinkled onto coarse sand with a light covering of the same sand. The punnet was placed into a slightly larger container holding water with drainage holes about 1cm up each side. This unit was then placed into a propagation tunnel with bottom heat and misting.
Planted in early December, the seeds had all germinated by late March but did not produce true leaves for over a month. The dicots looked very healthy (see right) but damping off became evident towards the beginning of May so the surviving 11 were tubed up and moved outside into the sun and fresh air. Once tubed, the seedlings progressed very slowly but most survived and seemed to appreciate open air and sunlight. *P. pedunculata* cuttings also seem

particularly slow to get going once tubed but one such plant has finally reached about 8 inches high some 5 months after planting.'

Marjorie Apthorpe, NSW has reported problems maintaining plants past the germination stage. Mark Noake's approach of moving germinated plants into a sunny, open position could be the answer in the cooler months.

Liesbeth Uijtewaal, Holland uses a great technique for identifying viable seeds – 'I generally soak the seed in smoke water (Kirstenbosch smoked paper discs) for 24 hours, then put them between two layers of moist kitchen towel in a drawer at room temperature. Germinated seeds are then potted up in potting mix with extra drainage and half strength Osmocote for natives added. Everything is done indoors, seedlings are grown under fluorescent light, 12h/day until big enough to go to the glasshouse or out in the open. *P. linearis* is the only successful Petrophile so far: I germinated some seed - from Nindethana- in November 2015, 4 out of 36 germinated after 11-17 days on moist towel, of course it took a while for them to appear above ground after planting the germinated seeds. Two seedlings remained in the end and budded up for the first time in February this year. [I had less success with] *P. biloba, canescens, conifera, fastigiata, linearis, prostrata, pulchella*. None germinated, I only had few seeds per species and I suspect the seed was old.'

DID YOU KNOW?

That pink form of *P. serruriae* you may have seen or photographed is now *P. axillaris*, a recently reinstated species.

David Lightfoot, Vic reported a similar method to Liesbeth based on Paul Kennedy's hakea seed raising method in an early newsletter – 'This method involves placing the seed within a folded-up piece of damp paper towelling. This is then put into an empty (plastic) bread bag that is tied closed and placed in a sunny spot. The seeds are periodically inspected and then potted once they germinate. I tried it with some seed of *Isopogon asper* I had collected on the trip. (They had no other pre-treatment- e.g. smoking.) I found that the seed did indeed germinate quickly (only about 2 weeks) and viable could be sorted from non-viable seed. It remains to be seen if the survival rate of these seed once potted up increases with this method, but it certainly looks promising.'

Rhonda Daniels, NSW has had good success propagating *P. pulchella* and *P. sessilis* from seed in Sydney – 'I volunteer at Sutherland Council Community Nursery which propagates them from seed. Always seem to have a lot of them, so no problems with collecting or germinating seed, or potting on. Probably have more Petrophiles than Isopogons. Sown into shallow trays in standard nursery seed raising mix (the mix for seeds and cuttings is just 50% perlite and 50% vermiculite), then potted on into tubes. Hardest part is probably getting the seed/cone heads at the right time and extracting the seeds.'

For those in winter-wet southern and western parts of Australia, **Alex George** confirms the benefits in mimicking nature in germinating *P. seminuda* from seed **– '**No special treatment – sowed in local sand in winter, outside, i.e. received only rain. Time to germination not recorded; planted out in spring and hand-watered for first summer. As a very general observation, I have had better success in germinating seed of native plants by leaving them in the rain, i.e. in contrast to using scheme (tap) water.'

DID YOU KNOW?

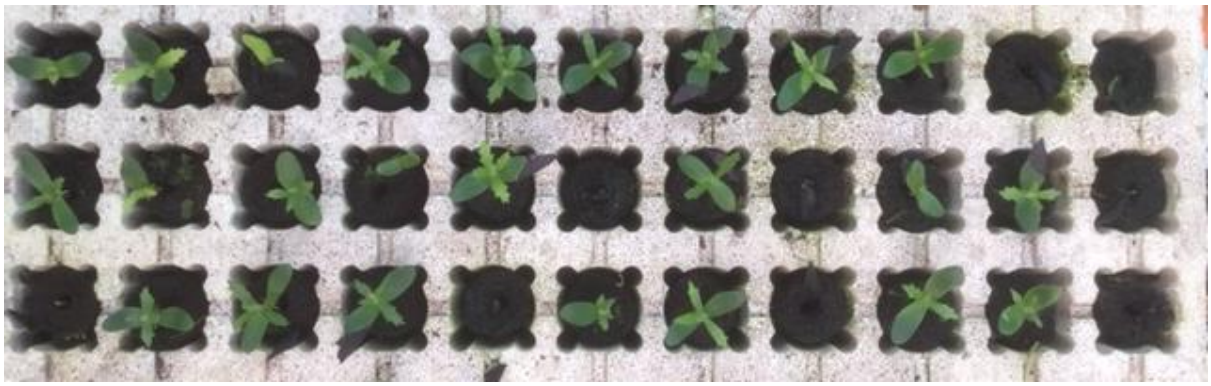
Mounded *P. longifolia* is one of our favourite species, but the species we know as such has been changed to *P. filifolia*.

Robbie Blackhall-Miles, Wales has successfully germinated *Petrophile canescens*. – 'We used H2O2 and smoke for germination. 7 seeds germinated out of 10 but only one still survives. We still have this plant in a 1L pot. It is about 15cm long after 2 years but seems to want to grow horizontally.'

Potting on losses

Reported issues with potting on emergent seedlings are frustrating after all that effort getting them to germinate. I have been trialling a method which may help reduce this problem. Following great success with using 20mm peat plugs to germinate banksia seeds, I planted a batch of *P. pulchella* seeds into the plugs. Germination time was around 30 days and germination was an acceptable 50%, but the big advantage of the plugs is that when you pot them on there is no loss due to root disturbance. I find that plants potted on from

the plugs (the plug is simply potted on with the seedling growing out of the plug) can be immediately transferred into full sun with no losses. The plugs can be purchased from Garden City Plastics, along with foam trays which hold 240 plugs (see photo below).



Key tips for propagating petrophiles from seed

- Use the freshest possible seed by selecting the youngest ripe cones
- Test seed between moist sheets of paper towel to identify viable seed then sow viable seed only
- Sowing seed in autumn is preferable so that potting on occurs in the cooler months
- Be patient in waiting for your end product – progress can be slow
- Try sowing in plugs to minimise losses when potting on

Cuttings

Petrophiles are proving much more difficult to strike roots from cuttings than isopogons. Our Study Group members report occasional good success but then report difficulty repeating that success. Most members use the traditional approach of using semi-firm material and using hormones such as Clonex purple and bottom heat.

Members' experiences

Miriam Ford, Vic and her team at Yarra APS successfully struck cuttings last year of *P. pedunculata, P. sessilis* and *P. pulchella*, though a range of isopogons cuttings processed at the same time produced more abundant, stronger roots quicker than the petrophiles. Miriam reports some petrophile losses after potting up possibly reflecting the weaker root systems produced, compared to the isopogons. Miriam has excellent propagation facilities with misting and bottom heat within a glasshouse. The propagation mix she used was 50/50 coco-peat/perlite. This mix might be considered too heavy with coco-peat (I use 5 parts perlite/1 part coco-peat) but the bottom heat likely prevents the mix becoming too wet. Most of Miriam's petrophile cuttings were potted on after 5 months. However, some took just under 12 months before they had sufficient roots to pot on.

Mark Noake, NSW has had a lot of experience growing petrophiles from cuttings going back many years when he volunteered at Eurobodalla Botanic Gardens. – 'I'm coming to the opinion that fairly soft wood from healthy young plants might be important, also the state of the plant, such as is it starting a growth spurt, is of paramount importance. Cuttings of *P. sessilis, P. pulchella*, *P. pedunculata* took anywhere from 3 to 10 months to strike roots. That's why protection of the cuttings is so important. The percentage of cuttings striking roots varied greatly from 10% to 67%. Potting on didn't happen for at least 6 months, generally dictated by what stage of the growing season we were up to. For example, I would be more likely to pot on leading into spring when fertiliser will be better used. I used a native mix (Martins) with added perlite up to 50%.

Perusal of propagation records for our local petrophile species (*P. pulchella, P. pedunculata* and *P. sessilis*) reveals no real pattern of how to succeed. Going back 10 years shows varied results, sometimes 50% of cuttings will put on roots whilst at other times 10% or on one occasion 67% produced plants. In one case it took 10 months for roots to form.'

Marilyn Sprague, Vic has successfully struck *P biloba, P. squamata* and *P. fastigiata* with misting, bottom heat in a shade house. She uses semi hardwood cuttings and purple clonex hormone treatment.

Liesbeth Uijtewaal, Holland has had good success recently – 'Important: semi-firm wood, I used Clonex Purple on most, propagating mix well draining with a high proportion of perlite, in a basic propagator with bottom heat, indoors under fluorescent light 12h/day. Time of year: cuttings of *P. serruriae* taken in December (Australian time) failed, those taken in April (Australia) were very successful but failed to grow on.

P. ericifolia: 6 weeks to strike roots (1 of 13 = 8%)
P. fastigiata: 2.5 months (7 of 11 = 65%)
P. linearis (June, NL): 7 weeks (3 of 4 = 75%)
P. linearis (Oct, Aus): 4 weeks (2 of 3 = 66%)
P. pedunculata (Oct, Aus): 6 weeks (1 of 2 = 50%)
P. teretifolia (Oct, Aus): 3.5 to 6.5 months (2 of 3 = 66%)'

[Liesbeth's low success rate with *P. ericifolia* is common for members. It seems to be one of the most difficult petrophiles to strike roots.]

But given the less than acceptable results achieved by this traditional approach, is there something else we can try to break this reluctance of petrophiles to reliably strike roots. For example, on a recent trip to Victoria we were told of a method to force Philothecas to strike roots – soak in 50/50 methylated spirits and water for 15 seconds then rinse in water and apply hormones. Would this work for petrophiles? Let's all get experimenting to see if the study group can come up with a breakthrough!

Key tips for propagating petrophiles from cuttings

- Be patient in waiting for roots to appear
- Use semi-hard material but try softer material if you have a misting system
- Bottom heat and misting appear beneficial though not essential
- Remember we do not require high strike rates to produce plants for our garden

Grafting

Petrophile grafting is very much still in the early stages of development. In looking for suitable rootstocks we have established that petrophiles are not compatible with isopogons which is disappointing as isopogons strike from cuttings so easily. Lots of western species are proving to be compatible with eastern species although we still need to determine how tough eastern species are as rootstocks. We need rootstocks to be tough and adaptable to a wide range of conditions. Some populations are tougher than others and it is likely that we will need to test and select the toughest forms making provenance important. Members can help by trialling the eastern species in their own gardens and reporting back on results. The rootstocks showing potential in that they are compatible with western species and have been used in successful grafts are: *P. sessilis, P. pulchella* and *P. shirleyae.*

Another issue is that we need rootstocks to be easy to produce in numbers. The main constraint in progressing the grafting of petrophiles is the difficulty in producing rootstocks via cuttings. This makes testing for compatibility much more time consuming. Despite this, there have been many successful grafts produced by study group members Tony Henderson and Phil Trickett. We would love to have more members trying grafting, as the rewards of producing tough, reliable, long-lived plants are obvious.

The other important component for successful grafting is availability of a range of scion species. The same lack of availability which limits us growing petrophiles in our gardens also limits grafting trials. Scion material has to be grown from seed, collected as cuttings under licence from the wild, or collected as cuttings from the few garden specimens scattered around the country.

Tony Henderson has had success over many years using *P. pulchella* and *P. sessilis* as rootstocks. Tony's successful grafts are impressive. He has been a wonderful asset to the Study Group grafting a range of different species from scion material we send to him. But he is continually frustrated by the difficulty in producing rootstocks of these two species. Seedlings rather than cuttings is his most successful method at present, but the downside is that it takes a couple of years from sowing seed to produce plants large enough to graft onto. See Tony's report below. He uses stock plants raised from both seed (seedlings) and cuttings. Much of Tony's scion material (the petrophile species being grafted onto the rootstock) has been grown by him from seed or cuttings. Other scion material has been supplied by Phil & Catriona.

Tony is a goldmine of information on grafting a range of WA species and now he is using his experience with interstocks for petrophiles. An exciting development is his successful grafting of *P. linearis* with an interstock of *P. teretifolia*, and his plans to try interstock grafts with a range of other petrophile species. *P. linearis* has to be the most popular species we in the east still can't grow so this bodes well for our gardens in future.

My preferred use of the cutting graft technique (Tony mainly grafts onto established rootstocks) has proved to be a limitation in producing successful petrophile grafts, due to the low percentage of rootstocks that strike roots. My use of *P. pulchella* and *P. sessilis* has been almost a total failure due to almost none striking roots. However, the Queensland species *P. shirleyae* has proven much more successful, though there are still too many grafts that fail due to the stock failing to strike roots. Despite these issues, I have achieved a few successes – *Petrophiles megalostegia, divaricata, teretifolia, filifolia ssp. filifolia, prostrata, scabriuscula, imbricata, biternata* and *fastigiata*.

A key issue to be resolved to facilitate a rapid increase in the production of grafted petrophiles is the development of techniques to improve stock plant production via cuttings. I am pursuing a number of different ideas. An example using an aulax species is outlined in the following article.

Recommendations for grafting petrophiles

- Cutting grafts are easiest on *P. shirleyae* which strikes roots easier than other eastern species
- Otherwise grow stock plants of *P. shirleyae, P. pulchella* and *P. sessilis* from seed or cuttings
- Develop methods to reliably strike eastern species from cuttings to facilitate cutting grafts

Petrophile grafting results over the last twelve months – Tony Henderson's report

Petrophile acicularis – grafts well to seedlings and cuttings. It also sets viable seeds.
Petrophile anceps – grafts well to seedlings. The scion is off a struck cutting.
Petrophile biternata – grafts well to seedlings. The scion is off a 150mm high seedling.
Petrophile brevifolia – grafts well seedling to seedling.
Petrophile helicophylla – grafts well seeding to seedling.
Petrophile linearis – grafts well using *P.teretifolia* as an interstock. The stems used were very soft and 3-4 mm in diameter. Grafts well to both cuttings and seedlings.
P.longifolia/filifolia– grafts well seedling to seedling. Have also grafted to struck cuttings over many years.
Petrophile megalostegia – grafted to seedlings with the scion taken from a plant 180mm high are good grafts but are very slow to shoot. Seedling to seedling grafts grow exceptionally well.
Petrophile pilostyla ssp. *austrina* – grafts well seedling to seedling.
Petrophile plumosa – scion off struck cutting to seedlings and shooting now. I have periodically attempted this graft since 1985 and finally been successful.
Petrophile recurva – grafts well to struck cuttings.
Petrophile rigida – grafts easily to seedlings.
Petrophile seminuda – grafts well to seedlings, scion material from struck cutting. It also grafts well seedling to seedling.
Petrophile rigida – collected by Phil Trickett. Strikes and grafts well to seedlings and struck cuttings.

Petrophile sp. (original sand garden Cranbourne Botanic Gardens) – leaves 20 mm long, terete and blue-green in colour – grafts well to seedlings.
Petrophile striata - splits tape; union looks good, however it shows no change and then rots. No success.
Petrophile teretifolia – grafts well to both cuttings and seedlings. Have grafted this for many years.

Except for *P.recurva*, which is one and a half years old, these grafts are about 4 months old. Seedling root stocks for above grafts are P.*pulchella* and *P.sessilis*, are 50 to 100mm tall and soft. The seedling scions are soft material, approximately 25mm tall and cut off just above the cotyledons, with stems 1 to 1.5mm in diameter. Steady hands are required! I cut just above cotyledons hoping the root stock would re-shoot. I had mixed results.

Next time I graft *P. longifolia, P.prostrata* and .*P helicophylla* I will graft below the cotyledon. Next Spring I will try interstock grafts for *P.biloba*, *P. heterophylla* and *P.squamata*. Within about twelve months I will have a better idea of the level of success with the above grafts.

Left*: P. megalostegia* cutting grafted to *P. sessilis* on 31 December 2018. Right: Seedling graft *of P. megalostegia* grafted to *P. sessilis* on 25 January 2019. Note how much more growth there is on the seedling graft. Photo: Martha Henderson

Aulax trials

Phil Trickett

One of the surprising outcomes of a 2006 report **'***A new suprageneric classification of the Proteaceae, with an annotated checklist of genera***'** by Peter H. Weston and Nigel P. Barker was that isopogons and petrophiles are not as closely related as previously thought. This report used DNA analysis to show that the most closely related genus to *Isopogon* was *Adenanthos* (along with eight other South African species), while the most closely related genus to *Petrophile* was a South African genus *Aulax*.

On a recent trip to Bunnings we were surprised to see for a sale plants of *Aulax cancellata*, one of only three species in the *Aulax* genus. Our initial thought was could it be useful in any way in solving our grafting issues with petrophiles? Naturally we purchased a plant and the following trials are underway:

- Cuttings have been taken to see how readily it strikes roots. If so, it may be a possible rootstock for petrophiles, depending on how reliable it is in cultivation. Frost could be its major weakness.
- Grafts have been undertaken putting *Aulax cancellata* onto the preferred isopogon rootstock *I. mnoraifolius* to check compatibility. This is a bit of a longshot, but you never know until you try. If successful, then *Aulax cancellata* could be used as an interstock between *I. mnoraifolius* and petrophile scions.

I will report on results of these trials next issue.

A splash of red

Catriona Bate

Flushes of reddish new growth are common in proteaceae, providing a highly attractive counterpoint to green foliage. During development leaves contain anthocyanins rather than chlorophyll, giving a red, yellow or brown colour. Later, when fully expanded and toughened, the chlorophylls appear providing the green pigment. This delayed greening is a phosphorus-saving strategy whereby scarce phosphorus is first used to construct the leaf then recycled to make the chloroplasts. This is a distinctive and wonderful feature of many petrophile species and has been noted as a very desirable trait in the genus by Rodger Elliott. While it is not yet clear how common it is, our count so far is up to 15 species (see our list in the box). This is a lovely bonus in the garden, so may be an additional factor when considering which species are priorities for bringing into cultivation.

P. pedunculata

serruriae, divaricata, glauca, seminuda, fastigiata, squamata, teretifolia, brevifolia, striata, biternata, plumosa, circinata, acicularis, helicophylla, pedunculata

P. glauca

You can help add to our list by observing petrophiles in the bush as well as in gardens. If you find yourself in the bush in southwest WA in spring, bronze to coppery-red new growth will jump out at you – in petrophiles and a range of other proteaceae (including isopogons). We need to put in more effort on this ourselves. We have noted striking red new growth in *P. pedunculata* coming back after a fire but have not yet noticed if this is the case in the garden or a specific response to fire. Now in Autumn we are seeing red new leaf growth on young plants of *P. teretifolia* so maybe spring is not the only time. A change in leaf colour towards red in response to cold weather is common in isopogons but not so far observed in petrophiles.

Red stems are a similarly attractive feature. These recently purchased plants of P. filifolia (pictured right) had very striking red stems obviously putting on a spurt of new growth. They certainly stood out on the nursery shelf.

Another striking change in leaf and stem colour towards red has been observed in *P. seminuda* in summer. As a survival strategy in long dry periods, some plants change the structure of their leaf cells which breakdown and later reconstitute themselves after rain. Outwardly, this presents as a change in leaf colour from red/brown back to green. This amazing ability to change leaf colour and reverse it according to the weather (diallagy) is apparent in large numbers of *P. seminuda* plants in late summer north of Perth, for example along the highway. Widely reported by Alex George, Margaret Pieroni has also commented on this phenomenon, noting her amazement at the sight of the beautiful colours of the foliage of plants at Little Darkin Swamp, south west of York WA, in April – one of the most colourful being *P. seminuda*. No other petrophile species are known to have this habit, and no isopogons.

Natural hybrids

Catriona Bate

A small number of petrophile species are known to sometimes cross naturally with each other where they coincide geographically and have similar flowering periods. *P. pulchella* appears to have a greater tendency to hybridise than other species. Hybrids can be of interest for taxonomists but also their greater hybrid vigour makes them good candidates for gardens and for grafting rootstocks. Sometimes this leads to new cultivars but as yet there are no cultivars known of *Petrophile*. The known apparent hybrids are as follows.

1. ***P. pulchella* X *P. pedunculata***

Isolated hybrid plants or hybrid intergrading plants or populations occur on the central coast, south coast and central tablelands of NSW.

2. ***P. pulchella* X *P. canescens***

Intermediates occur in areas of the central tablelands of NSW (pictured, left).

3. ***P. pulchella X P. sessilis***

Apparent hybrids have been observed near Jervis Bay NSW. There is considerable variation in the leaf divisions throughout the population, with most resembling *P. sessilis* but with some closer to *P. pulchella* (see right). It would be interesting to check the Special Collections section at Cranbourne Botanic Gardens for possible hybrids given that these two species have naturalised and become so numerous there.

4. ***P. brevifolia* X *P. linearis***

These species may occasionally hybridise. A likely intermediate from Cockleshell Gully WA has pink flowers but more flattened leaves. However, the evidence is confused by the occurrence of a pink-flowered variant in *P. brevifolia* – one possible hybrid specimen was found in a location near Dandaragan where an isolated inland occurrence of the pink-flowered form coexists with the usual yellow form.

5. ***P. ericifolia* X *P. seminuda***

This hybrid is known from two plants at a single locality west of Lake Grace WA growing with the presumed parents. Although these species have a large area of overlap in their distributions they may not often grow together as they may tend to differ in habitat preference, with *P. seminuda* showing a greater tendency to occur in lateritic habitats. The hybrid resembles each of the parent species in one or two characters but is intermediate in most. For example its leaves are intermediate in length between those of the two parent species at the site.

6. ***P. serruriae* X *P. diversifolia***

A single plant of a likely intermediate has been observed in the vicinity of Mondurup Reserve near Mount Barker displaying leaf characters of *P. serruriae* but quite different flower characters (e.g. terminal flower heads). The assumed parent species were located close by (*P. diversifolia*) and around 15 metres away (*P. serruriae*). The area has been subject to successive fires. Cuttings were taken before the original plant was burnt.

Fire ecology

Catriona Bate

Petrophiles occur in fire-prone ecosystems and like other proteaceae have adapted to ensure survival. Thick woody bracts or cone scales protect and support the fruits from the elements and from fire after which they open to release the fruits. Whether petrophiles need fire to reproduce is another issue. We know that petrophile cones also open after drying out (via plant or stem death or cone removal). Some say being fire-adapted does not necessarily mean species are fire-dependent, with high-frequency fire regimes a possible issue for biodiversity conservation.

Most petrophile species are highly fire sensitive – being very flammable they are destroyed completely by fire. However, they have large seedbanks which allow them to reproduce quickly and renew the seed bank before the next fire. Examples of petrophile species known to have this adaptation to fire include *P. pulchella*, *P. sessilis*, *P. teretifolia*, *P. diversifolia*, *P. filifolia* (*ssp. laxa* pictured left with seed thickly dispersed underneath) and *P. latericola*.

Reseeder species like these release their seed en masse immediately after death. The seed drops to the ground below or are dispersed by the wind via their hairy margins. With some rain they will germinate and grow, then mature rapidly. Studies show that for *P. pulchella* seedlings, pure ash is the best medium for seed raising. Seedlings of co-occurring proteaceae like *Isopogon anemonifolius*, *Banksia ericifolia* and *Banksia serrata* did better in leaf litter.

For seeds, timing is everything. While a seed is itself quite tolerant to harsh conditions and can survive for many years dormant in the soil, once committed to germination the emerging seedling is vulnerable to its environment. To ensure the seedling has the best chance of surviving and ultimately reproducing, the seed perceives many factors such as light, temperature, and nutrients and integrates these cues into an informed germination decision. When rain arrives after fire, smoke residue is washed down into the soil. A flush of new growth soon appears as seeds detect the smoke and water. Species with this fire ecology are very susceptible to short fire intervals which may not allow enough time for seedbank renewal. They are also very vulnerable to long dry periods where there is not enough rain to allow germination and growth. Also, younger plants will have fewer old cones and therefore a smaller seedbank. Interestingly, species like *P. sessilis* must renew most of its seedbank every year – studies show that seeds in the older fruits rapidly lose germinability.

Some petrophile species are known to be fire tolerant in that they have a lignotuber which allows them to resprout from heat-resistant buds below ground. Instead of being killed these plants are able to withstand burning and grow back. While able to survive fire, resprouters are generally less able to reproduce by seed so may be constrained in increasing their populations or distributions and establishing successors for further generations. The species thought to have this adaption to fire are: *P. canescens*, *P. shirleyae*, *P. pedunculata*, *P. multisecta, P. linearis* and *P. brevifolia*.

The characters resulting from fire adaptation are important. Taxonomists often use such morphological differences to distinguish between species (for example, between *P. brevifolia* which has a lignotuber and the very similar species *P. latericola* which doesn't). In terms of propagation and cultivation, fire ecology helps us to understand the requirements and growth habits of different petrophile species.

In the garden resprouters tend to be slower to grow while they are setting their lignotuber and can be severely pruned if necessary as they will quickly recover. They are naturally dense shrubs less likely to require

regular pruning. Perhaps they are more suited to growing in pots. Reseeders will do the opposite, often producing very long, leggy canes in record time and overall are taller plants. They will produce a nice narrow, columnar habit but may be short-lived (or shorter-lived). If pruning from infancy to give a bushier habit, care must be taken not to remove next year's buds which are set very soon after flowering.

In the nursery the treatment needed for seed of different species may relate to whether they are reseeders or resprouters (lignotuberous). Reseeders are likely to self-seed in the right conditions – species observed doing so in gardens include *P. serruriae, P. sessilis* and *P. pulchella*. In contrast, resprouters may have less seed which may also be less viable. In grafting, lignotuberous species may be less suitable as rootstocks due to their tendency to resprout and their slower growth.

Keep observing petrophiles and send us your observations about whether you think species have a lignotuber or not. Seeders and resprouters can be found in the same locations but resprouters tend to dominate in habitats that are frequently burnt whereas reseeders flourish when fires are less common. Look for large patches of petrophiles of a similar species and age which indicates mass reseeding from past fire. David Lightfoot has noted hectares of massed *P. pulchella* and *P. pedunculata* in Blue Mountains forests, and *P. sessilis* around the Woronora Plateau. In recently burnt areas look for seed on the ground or new seedlings, or if plants are resprouting. On living plants, look at the stem where it meets the ground to see if it is single or multi-stemmed. You might expect low plants with a neat, mounding habit to have multiple stems coming from a lignotuber but as Margaret Pieroni points out this is not so. The first flower is central on the stem, then branches grow from around it and each branch has a flower on the top and so it goes on developing into a mound. So there is no lignotuber in species like P. filifolia which has the same habit as dryandras like *D. nivea*, also without a lignotuber.

The mounded *Petrophile* growth habit. Drawing by Margaret Pieroni

Conservation issues

Catriona Bate

Petrophiles are no different to other endemic genera in facing growing threats into the future, with changing climate and increasing development the greatest concerns. The number of species officially identified as potentially requiring conservation can only increase with time. This is most likely to occur in WA, but local threats will be an issue in the east of the continent. Taxonomy will likely be a major factor in WA given the many areas requiring further investigation.

There are no currently threatened eastern species of *Petrophile*. Even *P. multisecta*, found only on Kangaroo Island, is considered sufficiently common there. However, petrophiles tend to occur in fire-prone or built-up areas and so can easily become locally threatened. For example, *P. shirleyae* occurs in the coastal wallum lowlands belt of Southern Queensland where fire is responsible for much of the essential instability of the plant communities. In the Lower Hunter region of NSW, studies of the impacts of potential future development indicate a risk of losing the entire regional distributions of *P. sessilis* and *P. canescens*. There was a similar scenario for one of the potential sites for a second Sydney Airport. Holsworthy has significant vegetation communities taking in *P. pedunculata*, *P. pulchella* and *P. sessilis* – Badgerys Creek, a significantly degraded environment, was chosen instead.

Of the western Petrophile species, fourteen are currently considered to be threatened or possibly threatened. Only two of these species have had their conservation status comprehensively evaluated. The three species at the highest threat levels were all named relatively recently (since the year 2000), reflecting few known populations as well as taxonomic developments.

P. nivea and *P. latericola* are both declared **Threatened**, the highest level. Both are closely related to *P. brevifolia*, a group earmarked as requiring further taxonomic investigation – further splitting may add to the list. *P. nivea* (named 2002) is known only from the type locality where it is locally common. When searches showed no more populations could be found it was upgraded from Priority One to Threatened status. It was concluded that the future of this species is currently secure as it is passionately managed by Don and Joy Williams (Study Group members) on Hi Vallee farm. *P. latericola* (named 2010) is virtually confined to one area in the Whicher Scarp south of Busselton and is highly susceptible to Phytophthora and fire. The whole Busselton Ironstone area has been declared a threatened ecological community and is being managed, with a key activity being the translocation of five key plant species including *P. latericola*.

The remaining 12 species have priority status indicating some degree of threat and a need for further work to properly investigate threat levels and directions for conservation strategies. Of course, in these cases substantial taxonomic work has already been done and is current. There are other cases where this is not so (where taxonomic work is waiting to be done or specimens not yet collected) and so such populations remain outside the scope of conservation efforts.

Priority 1 - *P. vana* (named 2007) is known from only three collections from separate locations in the hot semi-arid region inland of Yalgoo and is threatened by mining-associated activities and goat-grazing. It was given priority **one** conservation status in 2006 recognising a relatively high threat level and very urgent need for further work.

Priority 2 - Five species have priority **two** conservation status, recognising their occurrence in only one or a few locations and vulnerability to threats. Further work is considered urgently needed. Most of these species are relatively recent namings, having been split from similar, more common, species. For example, *P. clavata* and *P. pilostyla* ssp. *syntoma* are closely related to *P. brevifolia*; *P. trifurcata* is closely related to *P. misturata*; and *P. conifera* ssp. *divaricata* is closely related to *P. incurvata* and *P. semifurcata*. All of these species occur in inland areas north of Perth. In contrast, *P. carduacea* (right) comes from around the Stirling Ranges further south and has been known since the 1850s.

Priority 3 - Six petrophile species have priority **three** conservation status indicating they are not under imminent threat but still require work. These species are scattered across several locations, all inland north of Perth except for *P. filifolia* subsp. *laxa* which is known from five populations in state forests southeast of Perth. *P. pauciflora* comes from the semi-arid region east of Geraldton towards Mount Magnet on granite breakaways. Again there are close affinities with other petrophile species and many recent namings. *P. filifolia* subsp. *laxa* is similar to *P. filifolia* subsp. *filifolia*, *P. septemfida* looks like *P. chrysantha* but is more closely related to *P. misturata* and *P. scabriuscula*, and *P. globifera* (left) is similar to *P. scabriuscula*. This category also has two species named in the 1850s – *P. biternata* which is quite distinctive and easily found in the bush and roadsides in inland areas north of Perth, and *P. plumosa* which is harder to spot in the Moore River area.

In the future further taxonomic work is likely to result in new species likely to need conservation.

The top petrophiles

A straw poll of our members reveals the top petrophile species are *P. biloba*, *P. linearis*, *P. filifolia* (sold as *P. longifolia*), all western species.

1. If we have to pick a Number One it has to be *P. biloba (*right, in a Grampians garden*)*, which just scraped in first. This species ticks all the boxes for flowers, foliage, habit, relatively easy to grow plus that special wow factor. Mike Beamish and Peter Olde recall spectacular displays by this species in the bush. This is one of the toughest species in cultivation. Marilyn Sprague has never watered hers and it grows in a dry semi-shaded position. For more information, see our profile in Newsletter 23.
2. *P. linearis* (below, in a Perth garden) is one of the few petrophile species with a well-known common name (Pixie Mops). This affectionate tag reflects the fact that it is probably the most familiar petrophile (although rarely grown), and arguably the most attractive. This species is all about the flower – one that even the most casual visitor to southwest WA in springtime could recognise and a favourite of photographers. It's loved for its large velvety pink inflorescences but its flat leaves were also noted. Liesbeth Uijtewaal and Alex George have strong memories of the first time they saw it in the bush. There is even a flower essence based on this species which claims to promote mental and emotional wellbeing!

3. Many members nominated *P. longifolia*, a plant with long, soft terete leaves. Margaret Pieroni singled out its attractive mounding growth habit while for Royce & Jeanne Raleigh and Erica Shedley it is the foliage. Fiona Johnson likes it 'because it appears to be thriving in my garden and is kind of funky'. Over the years this has been one of the more commonly available western species and so many growers know it. Previously considered to be a variant of *P. longifolia*, *P. filifolia* was reinstated in 2005. While similar, it is not the same as *P. longifolia* which is restricted to the area from Stirling Range to Albany and Manypeaks area. The fact that true *P. longifolia* has Priority 3 conservation status and has not been able to be located for specimen collection since 1968 means that the plants we grow are all likely to be *P. filifolia* (pictured right).

P. helicophylla, P. drummondii and *P. sessilis* were also nominated by several members. Foliage was key for *P. helicophylla* (everyone loves its corkscrew leaves as well as its prostrate habit) and *P. sessilis* ('it has an ancient feel' according to Mark & Carolyn Noake) which is also easy to grow for some. Flowers are the best feature of *P. drummondii*, its electric yellow candles rising above a pleasing low habit.

Also earning special mention were (in no particular order):

- Western *species P. teretifolia, P. diversifolia, P. ericifolia, P. fastigiata*, and *P. scabriuscula*
- Eastern species *P. shirleyae, P. canescens* and *P. pulchella*

Members like petrophiles because they are unique, intriguing and uncommon plants. Unusual and spectacular is how Miriam Ford describes them. John Nevin enjoys the interesting combinations of foliage and flowers and Alex George notes that every species has interesting features.

In this case familiarity leads to fondness with some nominating their local species and others the species they are growing in their garden. Most of our respondents were growers and so nominated as their favourites species that grow well for them. This is useful as it means we can recommend species that are not only attractive but also relatively hardy. In some cases, it is a solitary species (Robbie Blackhall-Miles in the UK has only *P. canescens* and Allan Carr in Queensland has only *P. shirleyae*, his local species). In Armidale John Nevin's favourites survive a cold climate (*P. ericifolia, P. scabriuscula* and *P. filfolia*). In the Grampians the Raleighs like *P. biloba* and *P. fastigiata* because they find them easy to grow. In Sydney Rhonda Daniels likes growing local species *P. sessilis* and *P. pulchella* with a narrow habit.

Inevitably this means that our favourite species are also the ones we can get. Availability is a big issue. There are not many petrophiles to be found in local nurseries but our members have been a big help in listing nurseries which may stock them from time to time. See our list below.

Coming up with a favourite species is difficult– for some a lack of knowledge was the problem while for others it was being spoiled for choice. There are just too many wonderful petrophiles! And too many reasons to like them. We like Alex George's approach – our favourite is 'the one I'm looking at now'.

Where to buy petrophiles

Difficulty sourcing petrophile plants is a major reason for them not being grown. It's a 'by hook or by crook' game with some of us having no choice but to try propagating ourselves. That's why we have our seed and cuttings exchange program. In the market it's only specialist nurseries or growers which might stock them and there seem to be fewer available than ever. It is encouraging that some eastern community nurseries are growing local species and this is a trend we need to encourage as they are currently even less available than western species. Easy availability has inspired a couple of members to grow local species and this is important as they are likely to be relatively hardy. In the past, APS groups in Victoria included a limited number of WA petrophiles in their sales but the only contemporary report we have refers to APS Maroondah. The only plant wholesaler potentially handling petrophiles is Native Plant Wholesalers at Mt Gambier.

Despite having quite a list of nurseries availability is limited. Each is likely to stock only one or two species and only have them occasionally. There is potential for nurseries to seek out petrophiles if we ask for them and create demand. And hopefully we may encourage some specialist growers to go back to growing petrophiles. Here is a list of possible sources as reported by members.

VIC	Kuranga Native Nursery
	Melton Botanic Gardens
	Vaughans Australian Plants Pomonal
	APS Maroondah plant sales
	Goldfields Revegetation Nursery Bendigo (occasionally)
	Geelong Native Plants*
NSW	Sutherland Council Community Nursery (tubestock of local species)
	Sydney Wildflower Nursery (occasionally)
	Boggy Creek Natives Bellingen
ACT	Cool Climate Natives (occasionally)

QLD	Coolum Community Native Nursery (local species)
	Tin Can Bay City Farm Nursery (local species)
SA	Brenton Tucker Native Plants*
	State Flora Nurseries Belair*
WA	Australian Native Nursery – Oakford WA (1 species)
	Zanthorrhoea Nursery – Maida Vale (1 species)
	Kings Park plant sales
	Morande Nursery near Albany
	Australian Plants Nursery Robinson

* Previously a source of petrophiles and likely to still have stock plants.

In the press

***Local Express: Delivering community news from Manyana-Bendalong to Bawley Point* NSW, Issue 66, 14-27 Jan 2019**

Iridescent Cone Sticks

Petrophile pulchella known as cone sticks

The iridescent yellow of the Petrophile pulchella, also known as cone sticks is a brilliant addition to the summer flowers which can be seen in the Ulladulla Wildflower Reserve.

When the flowers mature, they produce conical fruits which stay on the plant until fire or other damage signals it is time for the next generation to take over.

The foliage is sort after by professional flower arrangers because it is strong but lace-like and provides a good scaffolding in which to place specimen flowers.

It is closely related to the Drum Sticks, but is easily distinguished by its finer leaves. The fruits are not round and quite useless as a drum stick.

There are forty-two species of the genus Petrophile and they can only be found in Australia. The name Petrophile means rock-loving, which comes from the rocky site in Sydney where they were first described by European Botanists.

Pulchella comes from the Latin word for beautiful. Naming and describing plants in Australia was big business in the early 1800s.

It was not just scientific interest, but there was always the hope that a plant of great economic value would be discovered. One of the main movers in this enterprise was Sir Joseph Banks.

As a very rich young man, he accompanied James Cook on his voyage of discovery in 1770. On that trip, he collected so many plants that even the ship's bread room contained more precious specimens than food!

He did not come back to Australia, but remained closely associated with the English settlement and put a lot of time and money into making new discoveries here.

One of his ventures was to complete a full map of Australia and so he commissioned Matthew Flinders to circumnavigate and map our land.

He also paid for two famous Botanists, Robert Brown and Ferdinand Bauer, to accompany Matthew.

Early in May 1802, they sailed past Ulladulla and moored in Sydney. After completing the circumnavigation, and passing our part of the coast again early in June 1803, their ship, Investigator, was declared unsafe.

Matthew had to return to England to find a more sea-worthy vessel and the two Botanists decided it would be much more fun to stay in Sydney, rather than make the long round trip back to the other side of the world.

It was during this time that Brown named our Cone Sticks and hundreds of other plants.

Facebook: www.facebook.com/pages/Ulladulla-Wildflower-Reserve/212383959123113

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Financial Report

Total 31/10/2018		$1,227.31
	Bank balance $1,110.62	
	Cash on hand $116.69	
Donations		$400.00
	APS Bendigo $200	
	Wimmera Growers $200	
Total 25/04/2019		$1,627.31
	Bank balance $1,510.62	
	Cash on hand $116.69	