AUSTRALIAN NATIVE PLANTS SOCIETY (AUSTRALIA)

Isopogon & Petrophile Study Group

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STUDY GROUP LEADERS
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Isopogon crithmifolius, Norn Road, Dryandra Woodland National Park, September 2023.
See our profile on this species in this issue.

Issues of the *Isopogon & Petrophile Study Group Newsletter* are available at
https://anpsa.org.au/newsletter/isopogon-and-petrophile-study-group/

Exchanging cuttings & seed

This is a way to share propagation material between study group members. All States apart from Western Australia allow material to be mailed from NSW. If you would like to be sent cuttings/seed (may vary for seed-only requests):

1. Email us to check that material is currently available. NB: cuttings are more plentiful than seed. (isopetstudygroup@gmail.com).
2. Once availability is confirmed, purchase a prepaid ***EXPRESS POST*** satchel from Australia Post (Small $12.95 or Medium $17), self-address it, put in an envelope and send to:
   Isopogon & Petrophile Study Group
   PO Box 291
   ULLADULLA NSW 2539
3. We will then package up your cuttings/seed and send it back to you ***Express Post***.
4. An email will be sent to you on the day the package is mailed so that you can be ready to propagate as soon as the parcel arrives!

Species currently available are:
Isopogon – anethifolius, anemonifolius (1.5m or 0.3m size), axillaris, 'Coaldale Cracker', cuneatus (shrub or dwarf coastal form), dawsonii, divergens, dubius, formosus, latifolius, linearis, mnoraifolius, nutans, panduratus ssp. palustris, spathulatus, 'Stuckeys Hybrid', trilobus
Petrophile – acicularis, clavata, diversifolia, ericifolia, glauca, linearis, pedunculata, recurva, sessilis, shirleyae, teretifolia

We need to expand the available species list to include all species growing in members' gardens. If you can provide material from other species, please let us know so we can add them to the list.

IN THIS ISSUE

Dear members,
Climatic conditions in the garden continue to keep us on our toes. The tap in the sky here turned on again in November after six very dry months. This eliminated the menacing threat of a bad bushfire summer but returned us to the problems with moisture characteristic of the last few years in gardens on the east coast. Unlike banksias, where the new foliage suffers due to stress and insect attack in these conditions, we find that isopogons and petrophiles cope much better foliage-wise. However, even local petrophiles find our rich soils problematic in wet conditions. Even grafted petrophiles on local rootstocks seem to demand only mounded, free draining beds to flourish in our garden. Other members are having the opposite problem, with Paul Kennedy having a very dry time in Colac, Victoria, and Kevin Collins kept very busy watering in extreme heat in WA. This summer has provided yet another dramatic illustration of the different challenges to gardening between the Mediterranean summer dry climates of southern Vic, SA and WA versus the summer wet eastern NSW and Qld.

Since our field trip to WA last September, we have continued with I&P travels. In October we visited Victoria twice, finding good examples of *I. ceratophyllus* in the west at Mt Arapiles and south of Edenhope, and giving a talk at Yarra Yarra APS to a large gathering. In December we gave another talk to the SE NSW APS group so hopefully we have converted more people to I&Ps.

Our wet late spring and summer also spelled disaster for many of Phil's new petrophile grafts still in their pots growing on, taking

the gloss off what was otherwise a bumper season of grafting successes for Phil. See Phil's update on grafting trials by himself and Tony Henderson in this issue. We have also included an interim grafting compatibility summary chart for isopogons and petrophiles to assist grafters. The charts also include the viability of cuttings for each species. Member input is critical to update these charts so please contact us with your propagation successes and failures.

There has been a major taxonomic achievement with the resolution of two problematic Western Australian *Isopogon* groups – the spathulatus and polycephalus complexes. We summarise the paper which has resulted in two new species and a number of new subspecies.

With DNA analysis taking an increasingly dominant role in taxonomy, member John Knight makes the case that morphology still matters. Interestingly, the resolution of the isopogon groups spathulatus and polycephalus incorporated both DNA and morphological information. John has also drafted a very useful key for the four southeast Australian petrophiles.

We were thrilled to hear that a founding member of our group, Margaret Pieroni, was awarded an OAM in the Australia Day Honours for her contribution to botanical art. In this issue we celebrate the many achievements Margaret has made to Australian botany and specifically to the study of isopogons and petrophiles. This is an award so richly deserved!

Our members have been hard at work propagating and enjoying I & Ps in the garden and the bush. We have some lovely photos in the members' section. Gerard Satherley has had great success with his isopogon grafting, which will hopefully inspire more of us to try grafting.

Our featured species this issue are *Isopogon crithmifolius* and *Petrophile pedunculata*. We bet you have never heard of *Isopogon crithmifolius*! It is one of the spectacular pink WA species but never seen in gardens. *Petrophile pedunculata* is an underrated and relatively unknown eastern species which flowers profusely late in the year when not much else is in flower. It also has very distinctive flat, fern like leaves, a beautiful feature.

Catriona and Phil

From our members

Ian Roberts, Blyth SA

Fantastic newsletter as always. Very envious of your WA trip!
I've put 2 x I. formosus in our 8-8.5 alkaline soil. Both needed some iron, with one looking better than the other. Have just had a couple of P. biloba germinate with no treatment. Nothing else though, although seed may be too old.
Found the article on nitrogen toxicity interesting. I've struggled the last couple of years with hakeas & grevilleas. They look very poor until about a year old & then start to put on some decent growth. Toxicity has been suggested as the problem.
…Have just potted on most of the Coaldale Cracker & I. axillaris you sent. Nothing still with the other 2 yet. Thanks again for sending. The Isopogon sphaerocephalus ssp lesueuriensis you saw dying has mostly died but 2 stems have remained & growing vigorously - go figure. Have potted on one cutting that struck, taken before too far gone.

Marjorie Apthorpe, Currowan NSW

November 2023: Thanks so much for the newsletter. I see that I have missed the deadline. But just for the record, my Isopogon formosus (right) flowered magnificently this year. It's now 7 years old, growing on its own roots, about 1.8 m high and wide; growing in clayey gravel/ gravelly clay, with a pH of 6. Strikes reasonably well from cuttings, but is slow to establish in our clay.

March 2024: I just wanted to report on the P. pedunculata (left and below) we found when looking at the Forestry Corp logging areas above our property. There is an area with a number of P. pedunculata and Banksia spinulosa (+ Persoonia levis and other things). This is a ridge-top location under Spotted Gum, that will be logged in the next couple of years. The Petrophile will all be bulldozed, on previous behaviour. We didn't see any elsewhere in the area. It seems to propagate reasonably easily but is very slow to grow on.

John Knight, Batemans Bay NSW

Thanks Catriona and Phil for another bumper edition of I&P's news. You guys are an inspiration, and I hope I can justify being more involved with growing some of the wonderful and wacky plants you come across. Keep up the good work.

David Lightfoot

Another bumper NL edition-THANKS. Looks like you had a fantastic trip to WA this spring. Sue and I headed to Eyre Peninsula SA this spring. Lots of excellent flora (and delicious seafood) but no I&P unfortunately. I see that you found Isopogon alcicornis when you were at Esperance- Did you see Isopogon villosus or Petrophile helicophylla two of my bucket list plants.

Over spring, I've had good flowering of Isopogon formosus, Isopogon buxifolius, Isopogon "candy cones", and Isopogon anemonifolius. I had a couple of flowers on small Isopogon dawsonii, Iso scabriusculus, Iso petiolaris and a couple of late Petrophile linearis inflorescences. Nothing on Petrophile shirleyae, Iso asper, Pet. prostrata, Iso prostratus, Iso sphaerocephalus, Iso trilobus, Pet fastigiata although many of those are still quite small. Isopogon inconspicuus grown from cuttings taken from you at ASGAP Kiama has flowered in the pot but is not yet in the ground. There have been a number of deaths including Isopogon mnoraifolius, and Petrophile pulchella, as well as two Iso latifolius (I don't think I'll try it again on its own roots here). It's been a very dry winter and early spring in Melbourne, and I am already watering a little. I don't think my tanks will last the summer at this stage, but fingers crossed.

Neil Marriott Halls Gap VIC

Out in the bush with Kevin and Kathy [in WA] and we found an unusual Petrophile that Kevin thought might be Petrophile rigida. However it has erect leaf lobes and the leaves are at least 5-8cm long. No flowers. It's probably Petrophile crispata. Also found lots of Petrophile media in full flower (pictured right) - low spreading plants only 0.3 x 0.5m with showy yellow flowers. Both growing in moist sand in Mondurup Reserve Mt Barker.

…Back home from a wonderful trip to the west. You gave us a plant of Isopogon mnoraifolius that you were using as a rootstock to grow and trial. Take a look at it now!! What a beautiful rootstock!! Looks great Neil! This is I. 'Coaldale Cracker'. It used to be incorrectly named I. mnoraifolius but is a hybrid between I. mnoraifolius and I. petiolaris. This would be the rootstock for

your grafted I. latifolius. Thanks Phil- it's a cracker alright!! And tough!! (pictured below left). This Petrophile teretifolia (below right) has now been flowering since mid winter and still has lots of flowers. I reckon this makes it a beauty for the garden!!

Kevin Collins Mt Barker WA

October 2023: Went to Margaret's site looking for I. axillaris but couldn't find them. Saw plenty of I. formosus. Some with small flowers right up the stem like the plants on Redhen Rd. Lots of tall spindly P. squamatas and a sole lovely bush of P. rigida (pictured) on the railway line.

November 2023: Well we had more amazing field trips with the focus on grevilleas with Neil & Wendy in tow and Liesbeth who admired everything. Kathy was able to join us most days and she enjoyed learning more species. We went along North Woogie Rd. but were time constrained and missed the main area. Only saw P. filifolia, the divided leaf form of I. longifolius and I. trilobus in bloom. At Cheynes the prostrate

I. attenuatus (pictured right) was in full bloom and a few blooms left on P. media. Did see one weird succulent leafed P. media (pictured above)...looked a little like H. clavata. The standout plant was Lambertia echinata in full brilliant yellow bloom.

I have a few new successes with cuttings of I & Ps. I. inconspicuus (ALL), some P. linearis, & P. chrysantha. I. panduratus subsp panduratus, P. nivea & P. ericifolia also looking promising.
The ones you gave me are mixed results. P. trifurcata all died rapidly? I. crithmifolius easy, as is dwarf P. squamata.

Others with possibility, too early to tell...P. striata, P. imbricata, P. anceps, I. scabriusculus, I. sphaerocephalus ssp. lesueurensis, P. longifolia low & P. merrallii. The latter which I've to confirm are just taking root after 2 years. (These appear to have the longest needle leaves of this complex). Another tardy one is I. nutans with 1 of 10 now growing after 2 years.

SO FAR the easiest species for me from cuttings have been: P. media, P. glauca (after 2 earlier attempts failed), all forms of P. squamata, I. pruinosus, I. sp. Fitzgerald River, I. sp. Ravensthorpe, P. seminuda, I. crithmifolius, I. formosus with the exception of the very course leafed form, I. longifolius, I. cuneatus, P. striata, I. dubius, P. diversifolia, P. filifolia & P. teretifolia. Also P. crispata.

SO FAR the easiest species for me from seed: I. formosus, I. dubius, P. teretifolia, P. squamata & a couple of P. helicophylla & a sole P. cyathiforma.

If I have inadvertently mixed I & Ps forgive me. I am in need of the NEW I & P book. ????

January 2024: Isopogon germination, using wet paper/fridge technique. Right: germination tray with seeds on paper towelling and a pic of one seed shooting. Most likely root pointing upwards with green being the cotyledon. Sown 12.11.23. Four germinated on the 23.01.24 (72 days). A further 4 sprouted by the 26.01.24. Result 8 from 13. Yes a mammoth 11 weeks. These are now potted up into native plant potting mix. We will keep you informed of progress. The remaining 5 seed are very small & unlikely to be viable. 3 x P. imbricata & 9 x P. trifurcata are yet to shoot. Seed still looks OK.

March 2024: A few of the I & Ps which appeared to strike haven't made it but better than 50% did take. I'll send you an update in a few weeks when I've finished potting up.

Lyndal Thorburn, Eremophila SG leader

Attached pic (left) is of a shrub planted in the Goulburn wetlands - doing very well but no-one seems to know what it is - even to genus. I suspect petrophile but that is as far as I can go - do you have any ideas pls? Hi Lyndal, looks like Petrophile canescens, going very well! Do you know who planted it? The group called FROGS - Friends and Residents of Goulburn Swamplands - or APS NSW Sthn Tablelands. I will let them know the species!

Evan Miller & Katrina Bornt, Bindoon WA

I'm a young farmer north of Bindoon with my wife Katrina. After we finished renovating our farm cottage, naturally the landscaping came next and we both got hooked. So much so that we have started a wildflower farm to help supplement the farm business (focusing on Australian natives but we also grow some South African proteaceae). I have I. formosus and I. latifolius growing in the flower farm (this is their first summer) and I have the following growing in our garden, most of which have flowered. Isopogon: latifolius, formosus, cuneatus, divergens, trilobus, dubius, buxifolius. Petrophile: linearis, serurriae. Very excited to learn more about these plants (particularly ones that have floriculture potential) and be a part of the study group.

Brigitta Wimmer, ACT

Nowadays I hardly get the opportunity to admire the Is & Ps in the wild, and I certainly don't propagate them. But I always remember you as very patient teachers to initiate me into the basic ID features of these plants. And I do love their looks, and actually sandstone flora in my opinion is far more spectacular than what we have here in Canberra. Day trips get me to about Nerriga-Tianjara Falls but that's about as far as I have gotten recently. Reading your last mammoth newsletter you sure follow all I & P trails and still are heavily involved in experimenting, improving and producing plants - and sharing your wisdom with your study group members. Looking at the articles I am amazed at how wide your readership is.

Having worked in the Federal Department of Environment on threatened species and ecological communities I seemed to have a lot more theoretical knowledge than what I needed to identify local vegetation in the field. It was really only after my retirement that ANPS Canberra Region helped me along in that respect and that I found time to take advantage of what our Society had to offer, particularly trips into sandstone country and further afield. I guess Isopogons and Petrophiles are just a plant group that always catches my eye because of the combination of their stiff or prickly leaves contrasting so beautifully with their showy flowers or cone-like fruit. We don't have a great variety of them around our area, and what I do know about them I owe to Phil's and Catriona's explanations on some trips. But there seems to be a proliferation of many different species right around the country, so I expect to very much enjoy the incredibly varied contributions from the Study Group members - absolutely amazing.

Darren Allen, Pokolbin NSW

We've had a rather challenging summer in this part of the Hunter with a number of extremely hot days, extended periods of 35 degrees + with no rain, along with some unusually high humidity at times.

I've had some success with cuttings of some of the material you sent in spring. I now have potted up plants of I. cuneatus, I. Stuckeys Hybrid, I. Candy Cones, I. formosus and I. Coaldale Cracker however all are still small. Unfortunately none of the cutting grafts from either last March or those done in September survived. I attribute this to the summer temperatures here which reached 43 degrees on some days. Despite shading and venting on the hothouse, and fog/mist every 6 minutes on the hottest days, (not directly on the grafts, just for general cooling), internal temps in the hothouse still got to 40 degrees on a few days. Even some of the few Eremophila cutting grafts I did in Spring, which are generally fairly tolerant, suffered with low rates of success this season. I've adjusted my propagating mix and settled on a more open mix with more coarse river sand which has improved success rates with the Isopogon cuttings. I will persist with grafting Isopogons until I succeed. The potted plants are still small so material for grafting is not plentiful, but there are plenty of Eremophilas Banksias and Grevilleas in the garden to practice on.

It's been a tough summer in the garden with the hot days taking their toll, combined with above average humidity for our area. We lost 2 candy cones in the garden, the original plant that had been there for a couple of years and another that I struck as a cutting, although I do have a few back-ups. They will stay in pots until I get the grafting bit sorted. Other losses were I. formosus (grey foliage), I. formosus x dubius, Petrophile serruriae and P. ericifolia. It's always a dilemma in the summer here, should I water or should I not, I decided to water on occasion this year, but not sure whether this helped or hastened the demise of some plants. I. dawsonii and I. Coaldale Cracker are doing well, and a couple of forms of I. anemonifolius are ok but clearly suffered on the hot days despite being in part shade.

The failures with the grafts are frustrating but I am determined to keep plugging away. I've set some cuttings of I. dawsonii to see if it will work as a rootstock, (has anyone tried it?) as the Coaldale Cracker cuttings have still been slow to strike for me, even after following Phil's advice on propagation in the last newsletter. I. dawsonii has been used as a stock for grafting but very rarely. This species is probably not tough enough in all situations. Wondering if the wider fluctuation in day/night temps here may be a factor? I don't have trouble striking other genera, and I. cuneatus, Stuckeys and Candy Cones struck reliably, I. formosus less so. I still have a cutting each of I. axillaris and I. divergens hanging in from last Autumn, but without roots as yet. All cutting grafts and cuttings of I. spathulatus, I. panduratus ssp palustris and I. dubius failed. I'm still using nescofilm so I don't think the taping is an issue with the graft failures, and I've tried doubling up the tape as Phil suggested in the last newsletter, still no success. Success with Eremophilas suggests that the knife work may be ok? I remember Phil talking about the number of failures when he started experimenting with grafting, so maybe I'm still paying my dues as an apprentice. ☺

I really appreciate all of the knowledge that you have passed on, hopefully some of the above may help others even if it only confirms what doesn't work.

Gerard Satherley, Forresters Beach NSW

It is early days, but it appears that I have managed to graft several Isopogon species onto I. 'Coaldale Cracker' rootstocks. The whole process was made easy because Coaldale Cracker propagates so readily from cuttings. My initial attempts proved problematic as the cutting material I had taken was too thin to work with. Lesson learnt. My next batch of thicker stemmed cuttings were a lot easier to match with the available scion material. I used mainly wedge grafts onto rooted cuttings. I'd estimate that my success rate is about 70% which is probably a bit higher than I manage with my Grevillea grafting. For me the biggest issue is finding suitable scion material.

Pictured a few of my successes I. trilobus, I. 'Pink Drumstick', I. axillaris.

I expected to lose a lot of Isopogons that are growing on their own roots over the last few months due to very high humidity we have experienced on the Central Coast of NSW. Fortunately, I have lost only two I. formosus plants. I think my decision to grow all my West Australian species/hybrids in root pruning pots that provide excellent drainage has paid off.

Prunings

'Coaldale Cracker' available for sale

We have long recommended this isopogon hybrid (*Isopogon petiolaris x I. mnoraifolius*) for gardens. It is easy to propagate and grow, hardy and attractive. Recently it got the stamp of approval from legendary horticulturalist Neil Marriott: '*It's a cracker alright!! And tough!!*'

However, it has been difficult to source except as cuttings through the study group and we need to get it more widely propagated and sold in nurseries. Boggy Creek nursery near Dorrigo was the original producer (sold as *Isopogon mnoraifolius*) and now Mole Station Native Nursery are producing plants under the 'Coaldale Cracker' name (it was their Plant of the Month for December 2020). Recently we have seen advanced plants for sale at Cool Climate Native Nursery in Canberra. This hybrid may also soon be available at Canberra ANPS (Australian Native Plant Society) plant sales.

Petrophile bonsai

Did you know that you can use isopogons and petrophiles for bonsai? Here (left) is an example using *Petrophile seminuda*.
Photo: Morande Native Plant Nursery Facebook page.

Great expectations

Every year in autumn we get the first flowers appearing on *Isopogon cuneatus*. This year is no exception – the first flower head burst into flower a week or so ago. This is one of the 'spectacular pinks' as we call them, easy to grow, easy to graft, and flowers all through winter. We have several plants dotted around the garden to brighten cold days. Note this species does not tolerate frost very well so a sheltered spot is best in frost-prone areas.

Isopogon cuneatus is one of the species that benefits from pruning as it is a vigorous grower. One advantage of pruning is that it produces many more flower heads. It is a very floriferous species and has several flushes through winter in good conditions.

This grafted plant of *Isopogon cuneatus* grows right near our house where we can see it all the time. As you can see, I pruned it thoroughly once the flowers finished in late spring (well, they had almost finished, as the bees still hanging around reminded me). There are no signs of pink flowers yet on this plant, but the resulting growth and number of buds looks to be something of a record. We are looking forward to an especially impressive display from this plant this winter.

Marilyn's Wildflowers

Marilyn Sprague, a study group member, has an amazing garden of Australian natives near Bendigo. Here is a recent post from her Facebook page. The arrangement of wildflowers (pictured right) features *Isopogon cuneatus*.

'*Did you know that the outdoor garden vase is a very beautiful thing!? For the recent 10th Australian Wildflower Conference Garden tours I filled mine with wildflowers. The … recycled gas bottle flower/pot stand made by @Andre Sardone Art (my next door neighbour) … contain[s] massed wildflowers. It attracts birds, butterflies and people.'*

Heatwaves in WA

By all reports the 2023-34 summer was WA's hottest on record. An extreme heatwave of seven 40°C-plus days in a row hit Perth in February, well beyond the previous record of four days set in February 2016. The day Perth reached 42.3°C, Geraldton had a top of 47.7°C. The average summer temperature recorded at Perth airport has increased by about 3°C since 1910, well above the national average. For 24 hours in mid-February, the 15 hottest places in the world were in WA.

Isopogons and petrophiles have hard cone scales to protect developing seed from extreme heat. Some species have an underground lignotuber or thick and/or small leaves which help them cope with heat. In some cases, foliage will temporarily lose its green colour in extremely dry weather and revert to green when moisture is restored. The leaves of *Petrophile seminuda* and *Petrophile squamata* turn red under heat stress, while *Isopogon scabriusculus* can turn pale.

While native plants have evolved to cope with heat, such extremes will really test them out. If the frequency and intensity of extreme heat events increases, plants are likely to reach their thermal limits and show slower growth or increased mortality. Given that around 90% of isopogon and petrophile species occur in the southwest of Western Australia, this is a concern, and we need to monitor how wild plants cope with extreme events such as the recent summer heatwaves.

Margaret Pieroni: a lifetime passion for wildflowers leads to OAM

Our own Margaret Pieroni, a founding member of the Isopogon & Petrophile Study Group, was recently awarded a medal (OAM) of the Order of Australia in the General Division for service to botanical art. Margaret's botanical achievements also include extensive native plant research. Her botanical work, research and artistic, has also been recognised by a life membership of the Wildflower Society of Western Australia and by the naming of *Grevillea pieroniae* in her honour.

It is wonderful to see Margaret's lifetime of passion and knowledge, her inspiration of others and her immense contribution recognised by her country. Congratulations Margaret from all the members of the Isopogon & Petrophile Study Group.

As native plant lovers we all dream of moving to Western Australia so we can live amongst the amazing plant diversity there. Margaret is one who actually did it, and she continues to make full use of the opportunity to explore, learn, draw, and teach others about the unique plant life there.

As many would know, Margaret is the pre-eminent expert on dryandras. And, as she explains, isopogons and petrophiles tend to be found in the same places as dryandras. She loves to tell the story of how the Isopogon & Petrophile Study Group began with a discussion between Margaret, Paddy Lightfoot and David Lightfoot at a Native Plant Society national conference. As a result, David took on the challenge to start a study group, issuing the first Study Group newsletter in November 2001. Margaret went on to design and execute a logo for the study group depicting *Isopogon latifolius* (left) which appears on our masthead. Margaret has an amazing photo library of these genera amassed over many years, plus an encyclopaedic knowledge of species locations in the southwest of WA. Jaunts into the bush with Margaret looking for dryandras, isopogons and petrophiles (DIPs trips as she calls them) are a real learning experience.

Here is Margaret's account of how her lifetime love of the bush developed. Luckily for us, her appreciation of the proteaceae led her to dryandras and also to isopogons and petrophiles.

> I grew up with a love of the bush which surrounded my home in Cabramatta, an outer suburb of Sydney. Holidays were spent at Durras, on the south coast of NSW and at Sunshine on Lake Macquarie, where my grandparents had retired to and where I would spend hours wandering through the bush looking for wildflowers and sometimes painting them. I loved the banksias though I found them too difficult to paint until much later in life.
>
> I had always wanted to go over to Western Australia to see the wildflowers and the opportunity arose in 1973. After I suffered three years of chemotherapy to treat acute leukaemia and not expecting to be cured, my parents decided to buy a caravan and the three of us had a delightful trip of about three weeks. I was armed with the recently published *Flowers and Plants of Western Australia* (Erickson, George, Marchant and Morcombe) and *Western Australian Plants for Horticulture* Parts 1 and 2 by Ken Newbey, published by ASGAP.
>
> After I returned home, my husband decided to fly over to Perth to see whether he liked it and returned with the news that he had bought a house in the suburb of Attadale. So within 12 months of my visit, we were

living in Perth with our young son. I joined the Wildflower Society and began growing and painting some of the wonderful Western Australian plants. I had a particular interest in the Proteaceae and that led to a specialisation with *Dryandra.* I grew and painted several isopogons and petrophiles and when David Lightfoot started the study group, I immediately signed up.

In 2004, I moved down here to Denmark on the south coast. There is just one petrophile, *P. diversifolia* which occurs naturally on my one-acre block. *Isopogon sphaerocephalus* grows on nearby Mount Hallowell. I continued to propagate, cultivate and paint several plants such as *I. axillaris, I. formosus, I. cuneatus* (3 paintings) *I.* Stuckey's Hybrid and *P. helicophylla,* I also grew one of my favourite plants *P. filifolia* but I didn't paint it because to remove a piece of the plant would have spoiled the bush as it has the mounding habit of growth that is common in several *Dryandra* taxa. I did however photograph each year's incremental flowering and growth. Unfortunately, it died after 6 years.

Illustrations of isopogons and petrophiles that have appeared in print are:

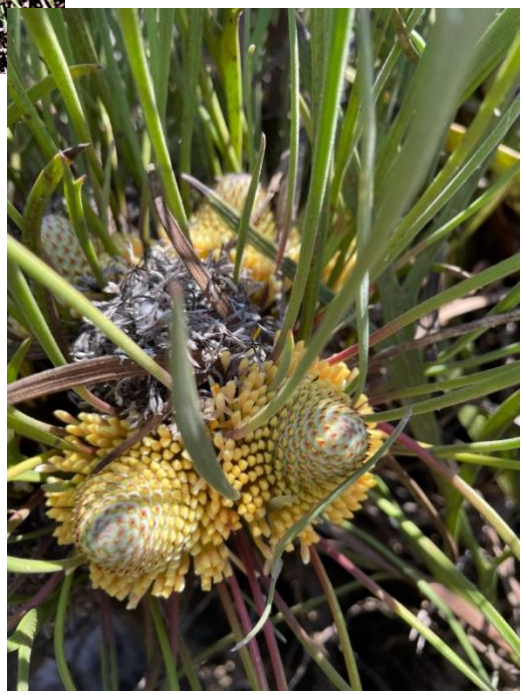
- In *Discovering the Wildflowers of Western Australia* (Margaret Pieroni) – *Isopogon dubius, I. latifolius, I. divergens. P. biloba, P. divaricata,* and *P. linearis.*
- In *Brush with Gondwana* (The Botanical Artists Group of Western Australia) – *Isopogon cuneatus.*
- In *Natural Connections. Commemorating 40 years of the Ravensthorpe Wildflower Show – Isopogon formosus.*

Editor's note: Margaret Pieroni has also produced original watercolour paintings of both genera which have pride of place on the walls of houses like ours. The species include *I. axillaris, I. baxteri, I. cuneatus, I. formosus I. '*Stuckey's Hybrid', and *P. helicophylla.* She admits there may be others she has forgotten about!

Is *Isopogon alcicornis* under threat?

Isopogon alcicornis is a low mounding species which grows in the eastern part of southern Western Australia, in far-flung areas inland north and east of Esperance away from towns. Not common, its distribution ranges around 150 km from Dalyup east to the Cape Arid region. It is found in proteaceae heath, low/mallee shrubland or eucalyptus woodland.

Isopogon alcicornis is currently classified as possibly threatened and is relatively low priority for conservation. It is on Priority Flora Lists as Priority 3 – a poorly-known species in need of further survey but known from several locations and not under imminent threat. The WA Department of Biodiversity, Conservation and Attractions (DBCA) do not actively manage or monitor the majority of low priority species due to their prevalence in the landscape relative to threatened species.



This species is not well known. Many location records are very old and little research has been carried out. In total, only 28 locations have been recorded, most of which are very old records. Three new populations were found in 2020. Unfortunately, that discovery was made in the context of surveys for a road upgrade which led to the removal of plants. The population affected consisted of 14 live plants, and the sacrifice of six of these (or nearly half of the local population) for the road widening was justified by the species having a wide overall distribution, and the loss of nearly half the colony was considered to have little impact on the local population.

The generative habit of *Isopogon alcicornis* is described as suckering from thick, underground stems. A suckering habit is rarely reported in isopogons. This species is also reported to be lignotuberous. About 39% of isopogon taxa are lignotuberous (29% of petrophile taxa). Both habits are evolutionary responses to fire allowing fast recovery of individual plants.

Suckering refers to new shoots developing from shallow lateral roots or near surface woody rhizomes. The shallow lateral roots often originate from a lignotuber. In the case of root-suckering species, root suckering networks are then able to extend themselves over time to form potentially long-lived colonies. These other vegetative regenerative strategies occur in proteaceae species such as banksias (e.g. *B. goodii*, *B. gardneri* and *B. candolleana* use rhizomes while *B. elegans* and *B. marginata* use root suckering, and *B. integrifolia* and *B. conferta* sometimes use root suckering). Grevilleas in the *G. linearifolia* group reportedly use rhizomes while *G. renwickiana* and *G. leptobotrys* sucker from roots.

As might be expected in a suckering species, *Isopogon alcicornis* is generally localised to small populations or colonies. See the distribution map, right. Populations are widely spaced across its distribution in natural sporadic, disjunct occurrences. The colony size varies from 5 to 100 with around ten plants most common. Plants in a colony are described as spaced or scattered over an area, the small shrubs occasional or frequent. Solitary plants have sometimes been observed but this is less common. Local decline from adjacent farmland clearance has been reported and may explain the presence of solitary plants. In our fieldwork we found that plants of this species occur under trees and are clustered in certain areas so are difficult to find unless you are in the right spot. We have only observed individuals that are old.

The suckering habit of this species means that plants in a colony are likely to be inter-connected, making whole colonies vulnerable to pathogens or disturbance. This species is regarded as an indicator species for phytophthora (root rot) due to its susceptibility to this fungal disease. Due to the interconnectivity of such colonies, the effects of phytophthora, drought stress, phosphorous toxicity, plus land disturbance and weed infestation can easily spread throughout entire populations.

The ability of suckering plant colonies to produce new individuals naturally by seed may be limited by a reduced capacity for long distance dispersal by seed, due to being surrounded by unsuitable (often cleared) habitat. Propagation trials by this study group show that *I. alcicornis* seed can be very successful but is not present in every (or many) mature fruiting cone. Thick short stems make cuttings or grafting very difficult and there is as yet no success reported. Growing plants on may be problematic; it has only ever been cultivated once or twice with the resulting plants now deceased.

It is not clear how much of the overall population of *I. alcicornis* is currently protected in reserves or national parks; while some plants occur in reserves, many occur on road verges. Road verges in WA are increasingly being degraded over time.

In summary, *Isopogon alcicornis* may be more vulnerable than is currently thought. While it is correct to classify it as a poorly known species in need of further survey but known from several locations, it should not be regarded as being so widely distributed that the loss of plants would not impact on the overall population. Entire colonies of this species could disappear very quickly, rapidly bringing it under imminent threat.

Fungal species discovered in *Petrophile pulchella* seed

A recent study on the seed microbiome of Australian plants (Mertin et. al., 2023) identified the fungal species living in seed of five native Australian species and included *Petrophile pulchella*. This is the first time that the presence and nature of microbes living in seed of isopogons or petrophiles has been identified.

Increasingly, the importance of the microbial community in ecosystem function, productivity, and health is being recognised. Research is now moving beyond soil microbes to the microbes present within all tissues of a plant. Little is known about the microbiomes of seed (especially in native species) which contain the embryo and specialised tissue to protect and sustain the early development of the next generation. Seeds can contain a wide range of bacteria and fungi within different tissue types, with a range of potential functions from disease resistance or promoting viability and germination to transmitting pathogens.

The other four native species included in the study were two banksia species (*B. ericifolia* and *B. serrata*) and two grass species (*Microlaena stipoides* and *Themeda triandra*). The *Petrophile pulchella* seed was wild-collected during June-August 2021 from ten host plants at a site in the Royal National Park near Sydney. The seeds underwent extensive surface sterilisation stages (immersion in 4% bleach then in 70% ethanol with multiple rinses in distilled water) before the fungi were cultured and DNA extracted.

A total of 21 fungal species were found in *Petrophile pulchella* seed (listed below) with varying levels of abundance. The most common was *Talaromyces chloroloma* (over 16% of total seed fungi from this host species) followed by *Jattaea algeriensis* (over 4%) and *Penicillium sp*. (over 1%). Two *Penicillium* species were identified – the *Penicillium* genus has been associated with producing toxic compounds thought to play a key role in defence against pathogens but have also been associated with causing seed disease and decay. *Penicillium glabrum* has been associated with increased plant growth in low-nutrient environments.

The seed microbiome may have a flexible component as well as a core. Core fungal taxa are consistently abundant and prevalent across individuals and populations. Flexible taxa are adapted to specific local constraints and reflect the site, where they can be acquired horizontally from the surrounding soil and as aerosols from the surrounding air. The study suggests that *Pestalotiopsis knightiae* and *Penicillium glabrum* are core fungal species for all five study plant hosts, i.e. for *Petrophile pulchella*. *Pestalotiopsis* is a species-rich genus that is widely distributed throughout tropical and temperate regions and is commonly isolated as a pathogen and an endophyte. *Penicillium glabrum* is a ubiquitous fungus, commonly associated with soil, decaying organic matter and as storage rots of seeds or pathogens of fruit and vegetables.

Interestingly, *Petrophile pulchella* did not share many fungal species with the two other woody, serotinous proteaceae host species (banksias) in the study. There were only slightly more fungal species shared with these relatives (nine shared with *Banksia ericifolia* and six shared with *Banksia serrata*, than with the two species of grass (the same five fungal species). The three proteaceae species co-occurred at one site (Royal National Park) but there were no 'core' fungal taxa across these host species. The highly abundant fungal species of the two banksias are very similar but different from that of *Petrophile pulchella*, suggesting that perhaps host relatedness plays a role in structuring site communities and that abundant fungal taxa may be captured through sampling seed from close relatives.

This study provides evidence that there is a complex and diverse seed microbiome within some Australian native plants. It also helped clarify how to capture the fungal seed microbiome of a site, by sampling seed of multiple hosts at the same site. To discover the fungal taxa of a host species, sampling at only one to two sites appears to capture most fungal taxa, but if we want to capture the complete fungal seed microbiome of a species, we need to sample seed from multiple sites. The authors propose that by taking into consideration the presence of a seed microbiome and its potential impacts on plant health, seed microbiomes could be used as one method to restore microbial diversity into an ecosystem and to contribute to the seedling microbiome and plant health at restored sites.

This new information about *Petrophile pulchella* is important for understanding its ecology and will help in conserving this species as well as its wider ecosystem. We need baseline data on how prevalent seed fungi are, what fungal taxa are present and similarities and differences among multiple populations of a host in these communities. Given that seed storage has been shown to lead to the loss of microbes, identifying core microbes may help direct conservation efforts in seedbanks. These microbes may be of particular value when using the direct seeding approach in degraded soils where the microbiome is poor, because the seed would provide the only source of microbes for the seedling until the aboveground parts of the plant have grown.

Fungal species found in *Petrophile pulchella* seed

Pestalotiopsis knightiae
Phaeoacremonium sp.
Penicillium sp.
Neocucurbitaria sp.
Diaporthe infecunda
Acidomelania panicicola
Fimetariella rabenhorstil -
Perenniporia sp. -
Heterotruncatella spadicea
Talaromyces chloroloma
Radulomyces notabilis
Coniochaeta luteorubra
Jattaea algeriensis
Pseudoplectania africana
Plicaria trachycarpa
Neophaeomoniella zymoides
Pyrenophora nisikadoi
Neoconiothyrium persooniae
Pyrenophora triseptata
Aureobasidium melanogenum
Penicillium glabrum

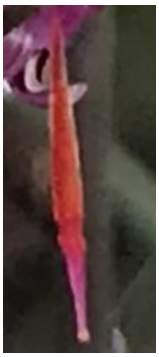
Mertin AA et al. (2023), Integrating seed microbiome knowledge into restoration and ex situ conservation of native Australian plants, *Australian Journal of Botany*, 71(7), 379–394. https://www.publish.csiro.au/bt/pdf/BT22109

Isopogon crithmifolius Mueller (1868)

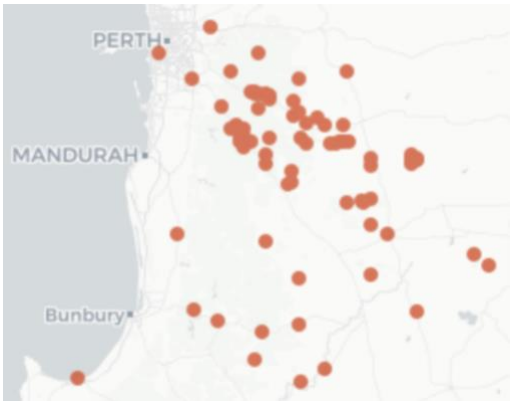
Isopogon crithmifolius was first described by Victorian Government botanist Ferdinand von Mueller in 1868 in *Fragmenta phytographiae Australiae*. James Drummond was the first to collect this species in Western Australia in the 1840s. The name crithmifolius refers to its leaves which von Mueller felt resembled those of the genus *Crithmum* (samphire, sea fennel plants).

Description –*Isopogon crithmifolius* is an erect open shrub to 2 m tall, without a lignotuber. The branchlets are pale brown and sparsely hairy. Flattened leaves are once to twice divided into three segments, i.e. ternately divided, the ultimate segments often further divided. The main leaf segments are concave. Young leaves have a coating of white hairs which diminish as the leaves mature. Leaves can be up to 40 mm in length with a petiole up to half this length.

Prominent globular inflorescences are sessile, teminal and mostly solitary. The large ovate involucral bracts are sparsely hairy (left) whereas the cone scales (below right) are densely woolly. Long pink to purple flowers are 25-30 mm in length and glabrous apart from a tuft of white hairs at the tip. The tepals split only part way to reveal a spindle shaped pollen presenter 5-6 mm long, the base longer than the brush with a clear constriction and bulge in between (right). It flowers from August to October with a spectacular display. The cones are globose to 15-20 mm long and the typical hairy isopogon fruit is beaked to 3 mm in length.



Distribution – *Isopogon crithmifolius* grows in forest or shrubland, often in laterite, from near Perth, south and west as far as Cranbrook near the Stirlings. An excellent spot to see this species is Dryandra Woodland National Park near Narrogin.



Confusing species – *Isopogon crithmifolius* is most likely to be confused with *I. dubius* or *I. formosus*. It resembles *I. formosus* in all aspects (especially the flowers and habit) except for its leaves which have flat leaf segments rather than terete (round in cross section) leaf segments. *Isopogon crithmifolius* has similar leaves to *I. dubius* in terms of flattened leaf segments with a linear groove or furrow, however in *I. dubius* leaves the furrow is more pronounced (channelled) and they are rigid and prickly. The flower heads also differ – *I. dubius* is hemispherical (round with a flat top) with prominent involucral bracts covering the

bottom half whereas with *I. crithmifolius* the inflorescence is globular and there are fewer involucral bracts which are confined to the base of the inflorescence.

Cultivation – not previously in cultivation and largely ignored by horticulturalists. However, *Isopogon crithmifolius* can be grown from seed and is likely to strike from cuttings. Initial grafting trials have recently been successful using *I. anemonifolius* as a rootstock. Like its closest relative *I. formosus*, it seems that an interstock of *I. cuneatus* is required although the suitability of *I*. 'Coaldale Cracker' as a rootstock is also being trialled.

Isopogon crithmifolius has significant horticultural potential so cultivation trials are important. It is a tall, graceful ornamental with spectacular flowers, attractive pink buds and interesting, unusual foliage. These trials should concentrate on selections of the most beautiful pink forms of the species.

Petrophile pedunculata R. Brown (1810)

Petrophile pedunculata was collected by Robert Brown in Sydney in the early 1800s and was first described by him in *Transactions of the Linnean Society of London* in 1810. The species name refers to the long peduncle or stalk below each flower head.

Description – *Petrophile pedunculata* is an erect shrub with a lignotuber up to 2.5 m tall. Usually tall, spindly and non-branching in open forest, it is more compact and around 1 m tall in coastal heathland. The long, soft, graceful leaves are quite distinctive at up to 20 cm long, the undivided part (petiole) shorter than the divided part on a flat plane (a third to a half of the leaf length). Leaves divide two to three times at an angle of around 45 degrees. Both leaves and branchlets are glabrous. Leaf segments are terete with a groove on the upper surface. Immature leaves are often red, particularly after fire.

Petrophile pedunculata has the smallest flower heads of the eastern species at around 20 mm in length. It makes up for this lack of size by being held up on a pronounced stalk of a similar length and with bright flowers and clustered flower heads. Involucral bracts are few, with most shedding on maturity. Cone scales are broadly ovate with an acuminate tip, green before and during flowering, and are hairy, becoming glabrous with maturity. Immature flowers are often lime-coloured followed by cream to bright yellow flowers each up to 10 mm long from late October though to December, with peak flowering in November. Flowers are fat and glabrous with the tips of each tepal remaining free before separating all the way to the base. Pollen presenters are spindle-shaped with a short, sparse covering of hairs. Fruits are up to 4 mm in length with long hairs at the base.

Distribution – NSW, grows in dry sclerophyll forest and wet and dry heath on sand or skeletal ridges; often on sandstone or in gravelly clays. Stunted forms may be found in swampy areas. Most populations are found on the coast and ranges around the Sydney area and south. It is a common species which is easy to find in the Blue Mountains National Park and Morton National Park. A good spot to find the low, compact form is in the South Pacific Heathland Reserve at Ulladulla.

Confusing species – Can be confused with the eastern species found in similar areas, *P. sessilis* and *P. pulchella*. Both *P. sessilis* and *P. pulchella* have much shorter leaves which are three-dimensional. In addition, P. sessilis has no stalk under its flower heads while *P. pulchella* may have a small stalk.

Cultivation – Propagation is relatively easy through cuttings and seed. Surprisingly, this lovely species is rarely seen in cultivation and is not available even in specialist native nurseries. It is very suitable for mixed planting. Its soft, beautiful foliage is perhaps its most attractive feature. This species is stunning in flower in November when not many other species are in flower. The taller form is slender and graceful while the low coastal form (more compact and with more flower heads) is suitable for containers or rockeries. It requires free-draining soils or built-up garden beds, and resents waterlogged soils in summer.

Below: *Petrophile pedunculata* compact form at South Pacific Heathland Ulladulla NSW.

A puzzle solved: new and revised isopogon taxa

Two Western Australian isopogon species complexes have long been problematic in terms of their taxonomy – the *Isopogon spathulatus* complex and the *Isopogon polycephalus* complex. These plants have entire, essentially flat leaves and are reasonably common. They occur south of Perth and east as far as Fitzgerald River National Park (*Isopogon spathulatus*) and the Great Australian Bight (*Isopogon polycephalus)*. *Isopogon spathulatus* is generally an upright shrub typically 0.5-1.5 m high with pink/white flowers. *Isopogon polycephalus* is a spreading shrub usually less than 1 m with clusters of white/cream flowers.

Each species group comprises a number of likely taxa with similar but varying forms (morphology). Traditionally, this variation would be the basis for classifying species. However, in this case the morphological characters are unclear or overlapping. Genetic analysis techniques, often applied to taxonomy these days, are a way to help resolve these issues. A new study integrates a genomic (genetic) approach with evaluation of morphological characters, geographic distribution, and ecology. The resulting revision of taxonomy has just been published in a paper by Benjamin M. Anderson, Rachel M. Binks, Margaret Byrne, Robert Davis, Michael Hislop and Barbara L. Rye.

RAD (restriction site-associated DNA) sequencing approaches have been effectively used to evaluate species boundaries in other plant genera. In this study, RAD sequencing methods (RADseq) were used to generate data for a range of population genetic and phylogenetic analyses. This use of genetic analysis along with other lines of evidence is a first for the *Isopogon* genus and has enabled a more nuanced assessment than would have been possible using a single approach. The results have allowed significant morphological information to be retained while also reflecting genetic differences.

A new species has been recognised in each complex – ***Isopogon pallidus*** (*Isopogon spathulatus* complex) and ***Isopogon elatus*** (*Isopogon polycephalus* complex). Both are conspicuously taller than other taxa in the same complex. Note the solitary flower head typical of the *Isopogon spathulatus* complex in *Isopogon pallidus*, and the clustered flowerheads typical of the *Isopogon polycephalus* complex in *Isopogon elatus*. Many SG members will be familiar with *Isopogon elatus* from visiting Mt Benson near Ravensthorpe.

Right, *Isopogon pallidus* (Photo: Fred & Jean Hort); far right, *Isopogon elatus.*

Within the *Isopogon spathulatus* complex, there are now three subspecies – the common typical subspecies (**ssp*. spathulatus***), the widely distributed **ssp*. elongatus*** further east, and **ssp*. obovatus*** which has a very small distribution. The typical subspecies *ssp. spathulatus* tends to have relatively short, crowded leaves and a short pollen presenter while *ssp. elongatus* has relatively long leaves (up to 70 mm long) and a long pollen presenter. The third subspecies, ssp*. obovatus*, has obovate or elliptic leaves and its pollen presenter lacks notable structures such as a pedestal or constriction.

Left*, I spathulatus* ssp. *elongatus.*

Left, *I. spathulatus* ssp. *spathulatus*

Isopogon buxifolius (below) is also part of the *Isopogon spathulatus* complex. As a species, its definition has been revised and the former varieties removed. One of these (var. *obovatus*) is now a subspecies of *Isopogon spathulatus*. Now a single taxa, *Isopogon buxifolius* shows genetic divergence as well as morphological difference from the rest of the complex. Its short, fat ovate leaves are distinctive. The breadth of this species has now been twice reduced since the last full treatment of *Isopogon* in 1995.

In the *Isopogon polycephalus* complex, note that the species *Isopogon polycephalus* remains unchanged meaning the only revision is to create the new species *Isopogon elatus*.

The table below lists the revised taxonomy in relation to the previous treatment.

	Previous taxon name	**Current taxon name**
***Isopogon spathulatus* complex**	*Isopogon buxifolius* var. *buxifolius*	*Isopogon buxifolius*
	Isopogon spathulatus	*Isopogon spathulatus* subsp. *spathulatus*
	Isopogon sp. Canning Reservoir	*Isopogon spathulatus* subsp. *spathulatus*
	Isopogon buxifolius var. obovatus	*Isopogon spathulatus* subsp. *obovatus*
	Isopogon sp. Fitzgerald River	*Isopogon spathulatus* subsp. *elongatus*
	Isopogon sp. Darling Range	*Isopogon pallidus*
***Isopogon polycephalus* complex**	*Isopogon polycephalus*	*Isopogon polycephalus*
	Isopogon sp. Ravensthorpe	*Isopogon elatus*

These outcomes are important for future study and monitoring activities. The following taxa are expected to retain their conservation listing priority status:

Isopogon buxifolius – Priority Two
Isopogon spathulatus ssp. *obovatus* – Priority Three
Isopogon elatus – Priority Four

While the results of this study facilitate study and monitoring, the priority status of these taxa indicates that their status in conservation terms remains 'possibly threatened'. Although conservation listed, they still lack sufficient information for formal conservation activities to be undertaken. Until further study is completed, they cannot be classified as threatened or vulnerable and so do not have any special protection under the WA *Biodiversity Conservation Act 2016*. Of greatest concern is *Isopogon buxifolius*, for which the precise habitat and location is unclear and invasive weeds appear to be a serious threat.

Perhaps the most significant outcome of this study is the loss of *Isopogon* sp. Canning Reservoir as a recognised taxon. Its status was previously Priority One indicating the highest level of concern and possibly threatened. An

indication of its scarcity is the fact that despite extensive searching no living plants could be located for this study. The study showed that, as well as lacking significant morphological difference, in genetic terms it had good connectivity with *Isopogon spathulatus* ssp*. spathulatus*. Based on this, it is considered to be a form or variant of that taxon and thus does not qualify for study, monitoring or protection by the WA government (Department of Biodiversity, Conservation and Attractions, or DBCA). It is now labelled as northern populations of *I. spathulatus* ssp*. spathulatus.* Similarly, insufficient evidence was found for a form of *Isopogon polycephalus*, an informally recognised variant also included in the study, to be formally recognised. This variant has a low mounded habit unlike the more usual erect habit of this species.

Recognising that the populations of the former *Isopogon* sp. Canning Reservoir could harbour adaptive genetic variation, the study authors note they may still merit protection as management units. This potential for forms of recognised species to have significant genetic variability is why monitoring variants is part of Study Group aims. Both the former *Isopogon* sp. Canning Reservoir and the low mounded *Isopogon polycephalus* will be part of our monitoring program.

The remaining taxa are not considered to be likely to need conservation listing. The new species *Isopogon pallidus* is known from multiple populations and will likely not qualify for conservation listing.
This paper marks an important milestone in the study of *Isopogon.* The culmination of years of research (including several years for this study alone), it required a special range of techniques as evidenced by its multiple authors. Not only does it resolve uncertainty delimiting species in both these complexes, but it covers off the outstanding formally recognised 'known unknowns' of the *Isopogon* genus.

Anderson, B.M., Binks, R.M., Byrne, M., Davis, R., Hislop, M. and Rye, B. (2024), Revised taxonomy for two species complexes of Western Australian *Isopogon* (Proteaceae) using RADseq. TAXON. https://doi.org/10.1002/tax.13129

Morphology matters

John Knight

What is morphology?

This derived from Greek (*morphe*) referring to form, and (*logos*) to research or study, and in relation to plants, is the study of external features and characters which we can recognise and differentiate. From this we shape our notions of where a particular plant sits within the structure of plants worldwide.
By studying these various characters, we can make choices as to what a particular plant might be, and observing these readily discernible features we can learn to recognise, then identify a plant. Note that the terms used to describe characters are understood by all botanists and plants people worldwide.

And why is this important?

There is a long history of classification based on plant morphology. Plants have been recognised for thousands of years based on their usefulness. Ancient civilisations based classification on uses, such as food, medicine and even poison.

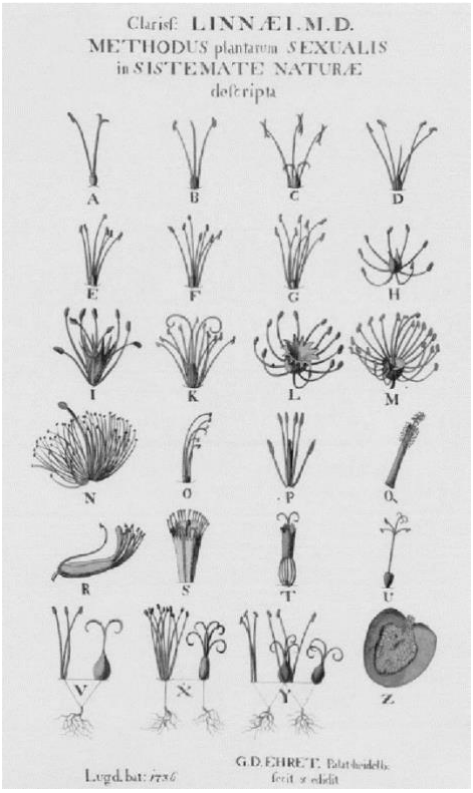
The Greek philosopher **Theophrastus** (c.371-287 BCE) classified around 480 plants based on their growth forms, such as trees, shrubs, herbs, and also noted differences in reproductive structures. Whilst such classifications worked for centuries, explorers were beginning to return to Europe from far flung corners with vast collections of new plants, unknown to modern science, and therefore needing sorting into workable groupings.

17th century plantsman, England's **John Ray** produced in 1690 the publication "Synopsis methodica" which laid down rules for a modern system of nomenclature. It was he who first used the term botany (from the Greek *botane* = plant) to describe the subject of his life's work. He introduced the concept of species, and developed the first natural system based on overall similarities. His 1703 edition of "Methodicus plantarum" included 18,000 taxa.

Plantago lanceolata
Photo: Pinterest

Plantago foliis ovato-lanceolatis pubescentibus spica cylindrica scapo tereti tells us that this plant (pictured, left) is a plantain, with ovate lanceolate leaves becoming softly hairy, with cylindrical flower head and a rounded stem. Whilst such a description might be acceptable when only a relatively small number of plants needed description, this system was proving unwieldy when applied to the many thousands of plants now arriving from around the world. A new, more efficient system was needed.

Recognised as the father of modern taxonomy, Carl von Linne (Linnaeus) published the first of his works in 1737. "Systema Naturae" detailed his concept of sexual classification based on floral structure, as depicted in the illustration (right). Literally, the System of Nature, through three kingdoms of nature, according to classes, orders, genera and species, with characters, differences, synonyms, places. (Wikipedia)



In 1753, Linnaeus published "Species plantarum" which described 6000 plants known to European science, basing the work of the sexual parts of plants. Part of this work describes plants with 5 stamens and one ovary, ***Heliotropium europeum***, foliis ovatus integerrimis tomentosis rugosis, spicis conjugatis, saying this Heliotropium has ovate leaves which are entire and wrinkled, with flowers connected in spikes. It is worth noting that Linnaeus placed the specific epithet europeum in the margins of the page, as it was intended that this would enable easier indexing of the work.

Image: Wikipedia

The science of classification

Taxonomy derives from the Greek ***taxis***, meaning arrangement, and ***nomia***, the method or distribution, from the verb nemein to manage, and its root nem, to assign, and is the science of classification.
"Quidquid latine dictum sit, altum videtur", or "Anything said in Latin sounds profound". Latin is the universal language of science for the very good reason that it is considered a 'dead language', meaning no new names or slang are used or created or changed through the years. So even if we may find the descriptions difficult, or profound, there is a very valid reason to maintain the tradition.

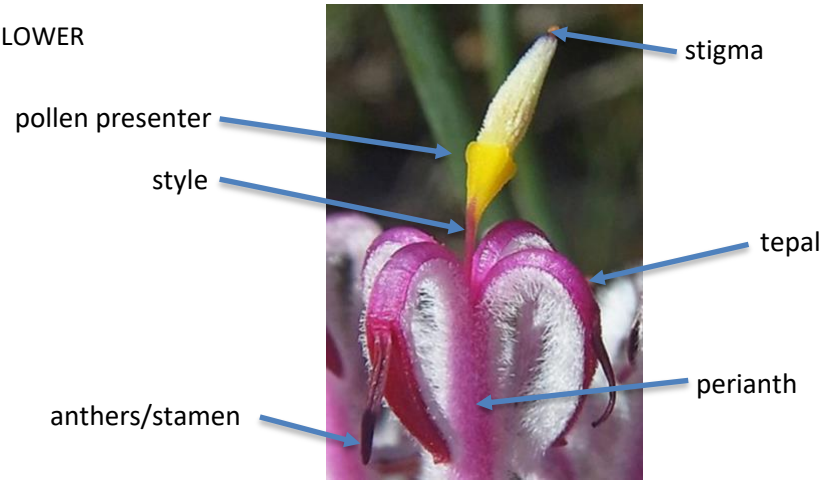
Taxonomic classification provides a standardised and universally accepted system for organising plant diversity. Taxonomic classification groups plants in Families, e.g. *Proteaceae* which have common characteristics suggesting they may have evolved from a common ancestor. Genera with similar traits are grouped in Families, whilst similar species are grouped in genera. The basic requirement of biological classification is showing a true genetic relationship.

Phenotypic classification (plant morphology) has several advantages for those interested in plants. These include simplicity, ease of observation and accessibilty. It is particularly useful for observing plants in the wild, to assist with recognition, or in the laboratory for identification. Phenotypic traits may be influenced by environmental factors, and as such leaves may be smaller or larger than typical, but the floral structure does not alter.

It is worth noting that the first published work on Australian plants, ***FLORA AUSTRALIENSIS***, was the result of many years work by English botanist George Bentham. Although he never visited Australia, he had access to all the herbarium collections held in Europe, and he was encouraged by Joseph Hooker of Kew. He also received all the collections of Australia's first permanent taxonomist, Ferdinand Mueller. Published in 7 volumes, from 1863 to 1878, the work provided identification keys for 8,125 species, and was the first completed flora of any large continental area. The *Flora* is based on morphological characters, but is arranged according to perceived evolutionary history.

What morphological characters determine that a plant belongs to the *Proteaceae* family?
The Family is named after the Sea God Proteus, noted for his ability to change shape. *Protea* is the name of a South African genus of this family, which is one of the most primitive in the world. Flowers of all members of the *Proteaceae* family have the following in common: absence of either sepals or petals (usually the sepals), and 4 petal-like structures and 4 stamens, each stamen in front of a petal (tepal) and often attached to it.
Isopogons and petrophiles have 4 tepals, each with stamens attached, and so belong to the *Proteaceae* family.

MORPHOLOGY OF ISOPOGON/PETROPHILE FLOWER
(*Petrophile teretifolia)*



What morphological characters determine that a plant belongs to the *Isopogon* or *Petrophile* genus?
Bentham, in volume 5 of his *Flora* (1870), included these genera in the **Suborder *Nucamentaceae***, in which the fruit is an indehiscent nut or drupe, and the flowers are usually solitary within each bract. This suborder was further divided into 4 Tribes, into the first of which ***Proteeae***, Bentham placed *Petrophila*, *Isopogon*, *Adenanthos* and *Stirlingia*. Distinguishing features which placed genera within the Tribe *Proteeae* are:

- Anthers all perfect
- Ovule 1 or rarely 2
- Stigma terminal
- Fruit a dry nut.

The key Bentham used to distinguish the Genera within the Tribe *Proteeae* is as follows.

1. Flowers in dense cone-like spikes or heads, with imbricate scale-like bracts, with few or many empty bracts forming an involucre. Anthers free.
    a. Cone scales firmly adhering to the rachis, tardy to fall
    Nuts more or less flattened — **Petrophila** (35 species)
    b. Cone scales deciduous, or remaining closely imbricate till they fall off
    with the nuts, which are not flattened — **Isopogon** (29 species)
2. Flowers solitary within an involucre of 4 to 8 bracts — Adenanthos
3. Flowers in small heads with very small bracts, anthers cohering round the style — Stirlingia

The morphological key, as arranged by Dr. Peter Weston of the National Herbarium of NSW, approached the division of Genera by a different route to Bentham, but arrived pretty quickly at the same conclusions. The key steps are:

a. Leaves alternate
b. Perianth actinomorphic (able to be divided more than once into identical parts)
c. Style tip differentiated from the rest of the style as a pollen presenter, usually swollen
d. Flowers borne singly in the axils of fleshy bracts in a dense, cone-like inflorescence, fruit a nut, ovule solitary
e. Cone scales falling with the fruits, nut not strongly compressed — **Isopogon**
f. Cone scales adhering firmly to the inflorescence axis, opening to release flattened nuts — **Petrophile**

With the production of ***Flora of Australia*** *Volume 16 (Elaeagnaceae, Proteaceae 1)* 1995, Botanist Dr. Don Foreman (National Herbarium of Victoria) expanded the number of recognised Petrophile to 53 species, and for Isopogon 35 species. The Australian Plant Census as at November 2020, lists 66 species of Petrophile, plus a number of taxa recognised at the lower level (subspecies). Similarly, Isopogon now holds 39 species plus taxa at the lower rank, and with continuing research in Western Australia it is likely that more species are yet to be formally recognised.

Being able to recognise the physical features of plants, and with these clues then identifying what a plant is, or might be, is a learned skill which makes growing plants challenging but rewarding. This knowledge also makes our bush rambles so much more satisfying. So, despite the move towards using DNA sequencing to determine genetic relationships, which requires serious laboratory equipment and techniques, I believe we are well served by understanding the various physical clues and features which allow us to say that **Morphology Matters**!

For an explanation of terms, see the Glossary on p. 28 of this issue.

A key to NSW petrophiles

John Knight

1	a	**young shoots** glabrous or mostly so		**pedunculata** **pulchella**
	b	**young shoots** at least pubescent (mostly covered with short soft hairs)		**canescens** **sessilis**
2	a	**mature leaves** glabrous		**pedunculata** **pulchella** **sessilis**
	b	**mature leaves** sparsely hairy		**canescens**
3	a	**angle of leaves to stem**	90 degrees	**sessilis**
	b		45 degrees	**canescens**
	c		45 degrees	**pedunculata**
	d		30-45 degrees	**pulchella**
4	a	**leaves** 3 - 10 cm long, undivided portion more or less equal to divided portion, segments rigid, divaricate, pungent		**sessilis**
	b	**leaves** 4 - 10 cm long, undivided portion more or less equal to divided portion, segments erect or ascending, not divaricate, not pungent		**pulchella**
	c	**leaves** 5 - 9 cm long, undivided portion longer than divided portion, segments erect or ascending, not divaricate, slightly pungent		**canescens**
	d	**leaves** 8 - 19 cm long, undivided portion one third to one half of total length, segments spreading, not pungent		**pedunculata**
5	a	**inflorescence** all species either terminal or axillary		
6	a	**inflorescence** sessile or pedunculate to 10 mm		**canescens** **pulchella** **sessilis**
	b	**inflorescence** pedunculate, peduncle 10 - 30 mm		**pedunculata**
7	a	lignotuber		**canescens** **pedunculata**
	b	no lignotuber		**pulchella** **sessilis**

Note that when the species are growing in close proximity, they each interbreed, so variation is quite common

Grafting update

With the grafting season coming to an end as the days shorten and the nights cool, it's time to monitor progress in grafting isopogons and petrophiles. Grafting I & Ps is still in its infancy, evidenced by the complete lack of grafted plants available commercially. But progress in assessing the viability of grafting I & Ps has been monumental over the last six years.

Much of this recent progress is due to the dedicated efforts of master grafter and study group member Tony Henderson who in his Sydney hobby nursery has experimented with techniques and compatibilities with isopogons and petrophiles over more than 40 years! Each year when we undertake our field trip to WA, we make sure cuttings and seed of species we study are air-mailed to Tony so that he can undertake grafting trials. Much of Tony's trials this season have been on Petrophile species yet to be grafted. And as usual Tony has had great success, adding a number of species to those successfully grafted (subject to long-term compatibility trials) onto either *Petrophile pulchella* or *Petrophile sessilis*. These include *P. anceps*, *P. aculeata*, *P. aspera*, *P. axillaris*, *P. brevifolia* ssp. *brevifolia*, *P. brevifolia* ssp. *rosea* (with an interstock of *P. teretifolia*), *P. helicophylla* and *P. juncifolia*. Tony also successfully grafted our Isopogon profile species for this newsletter *I. crithmifolius* using an interstock of *I. cuneatus*. This species has considerable horticultural potential but is never seen in nurseries.

I have also had a solid grafting season, initially successfully grafting a large range of isopogons and petrophiles through September and October. However the huge rains we received in November and December (820 mm) resulted in an unexpected loss of most of the Petrophile grafts due to the death of the stocks (both *P. pulchella* and *P. sessilis*). Interestingly no losses occurred with the Isopogon grafts, demonstrating just how much tougher *I.* 'Coaldale Cracker' is to waterlogged conditions. To prevent this happening in future years, I intend to improve the drainage of the potting mix used for petrophiles with a 30% addition of perlite to the mix.

Despite this Petrophile 'disaster' I did have three important successes with three Petrophile species of great horticultural potential *P. helicophylla* (right), *P. longifolia* and *P. axillaris*. All were grafted onto *P. pulchella*. Among the Isopogon species, pleasing successes (all on I. 'Coaldale Cracker') were I. *adenanthoides* (far right), *I. buxifolius*, *I. baxteri* (with an interstock of *I. cuneatus*), *I. longifolius* and *I. sphaerocephalus* ssp. *lesueurensis*.

Summary: grafting & cuttings results so far

We have decided to publish current grafting compatibility charts for each Isopogon and Petrophile species including known hybrids. It is important to note that these charts do not reflect long-term compatibility results for each species as many more years are required before these results become available. Instead, they reflect whether or not grafted plants have been produced which have grown on (i.e. produced growth) and have subsequently shown no signs of incompatibility. Information has also been provided on the viability of striking plants through cuttings.

We strongly encourage members to contribute to these charts by contacting us with their successes or failures in propagating by cuttings or grafting. This is a way all members can make a valuable contribution to the study group. Failures are also important information as there needs to be failures from many propagators before determinations can be made that a species cannot be propagated through cuttings or grafting.

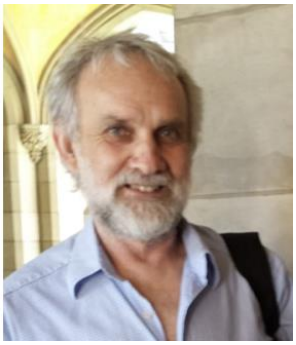
Note that these tables are very much interim, and much more work from the Study Group is required before they can be considered final.

Isopogon species	Cuttings	Graft I. 'Coaldale Cracker'	Graft I. anemonifolius
adenanthoides	Difficult	Yes	Yes
alcicornis			
anemonifolius	Yes		
anethifolius	Yes		
asper		Yes	Yes
attenuatus		Yes	Yes
autumnalis		Yes	
axillaris	Yes	Yes	Yes
baxteri		Yes with interstock	Yes with interstock
buxifolius		Yes	Yes
ceratophyllus		Yes	
crithmifolius			Yes with interstock
cuneatus	Yes	Yes	Yes
dawsonii		Yes	
divergens		Yes	Yes
dubius		Yes	Yes
elatus			
fletcheri		Yes	
formosus ssp. dasylepis	Yes	Y with interstock	
formosus ssp. formosus	Yes	Y with interstock	Yes with interstock
gardneri			Yes
inconspicuus		Yes	No
latifolius		Yes	Yes
linearis		Yes	Yes with interstock
longifolius	Yes	Yes	Yes
mnoraifolius	Yes		
nutans	Yes	Yes	
pallidus			
panduratus ssp. palustris	Yes	Yes	Yes
panduratus ssp. panduratus	Yes	Yes	Yes
polycephalus			
pruinosus ssp. glabellus	Yes	Yes	Yes
pruinosus ssp. pruinosus	Yes	Yes	Yes
petiolaris	Yes		
prostratus	Yes	Yes	
robustus			
scabriusculus ssp. pubiflorus		Yes	Yes
scabriusculus ssp. scabriusculus		Yes	Yes
scabriusculus ssp. stenophyllus		Yes	Yes
spathulatus ssp. elongatus		Yes	Yes
spathulatus ssp. obovatus			
spathulatus ssp. spathulatus		Yes	Yes
sphaerocephalus ssp. lesueurensis		Yes	Yes
sphaerocephalus ssp. sphaerocephalus	Yes	Yes	Yes
teretifolius	Yes	Yes	Yes
tridens			Yes
trilobus	Yes	Yes	Yes
uncinatus			
villosus			
'Candy Cones'	Yes	Yes with interstock	
'Coaldale Cracker'	Yes		
'Silvertips'		Yes	Yes
'Stuckey's Hybrid'	Yes	Yes	Yes

Petrophile species	Cuttings	Graft P. sessilis	Graft P. pulchella
acicularis			Yes
aculeata	Yes		Yes
anceps			Y with interstock
antecedens			
arcuata			Yes
aspera		Yes	Yes
axillaris		Yes	Yes
biloba			
biternata			Yes
brevifolia ssp. brevifolia	Yes	Yes	Yes
brevifolia ssp. rosea			Y with interstock
canescens	Yes		
carduacea			Yes
chrysantha			
circinata			
clavata			
conifera ssp. conifera			
conifera ssp. divaricata			
crispata		Yes	Yes
cyathiforma	No	Yes	No
divaricata			
diversifolia		Yes	Yes
drummondii		Yes	Yes
ericifolia ssp. ericifolia		Yes	Yes
ericifolia ssp. subpubescens			
fastigiata	Yes		Yes
filifolia ssp. filifolia	Yes	Yes	Yes
filifolia ssp. laxa			
foremanii			
glauca			Yes
globifera	No		
helicophylla	Yes		Yes
heterophylla			
imbricata			
incurvata			Yes
juncifolia			Yes
latericola	Yes	Yes	No
linearis	Yes		Y with interstock
longifolia	Yes	Yes	Yes
macrostachya			
media	Yes		Yes
megalostegia		Y with interstock	Y with interstock
merrallii			Yes
misturata	No		
multisecta	Yes		Yes
nivea			
pauciflora			
pedunculata	Yes		
phylicoides			Yes
pilostyla ssp. austrina	Yes		Y with interstock
pilostyla ssp. pilostyla			
pilostyla ssp. syntoma			
plumosa	Yes		Yes
prostrata			Yes
pulchella	Yes		

recurva	Yes		Yes
rigida			Yes
scabriuscula			Yes
semifurcata			Yes
seminuda	Yes		Yes
septemfida		Yes	Yes
serruriae			Yes
sessilis	Yes		
shirleyae	Yes		
shuttleworthiana	Yes		Yes
squamata ssp. squamata			
squamata ssp. Ravensthorpe			
squamata ssp. northern			
striata			
stricta			
teretifolia			Yes
trifurcata	No	Yes	
vana			
wonganensis		Yes	Yes
merrallii x seminuda	Yes		

Farewell Mark Noake



Mark Noake, artist, teacher, tech whizz, propagator and gardener, and member and great supporter of the Isopogon & Petrophile Study Group, passed away recently. Mark's first love was grevilleas but when we took on the I&P Study Group in 2015 he turned to isopogons and petrophiles with gusto. He already had experience propagating a low form of *Isopogon anemonifolius* at Eurobodalla Botanic Gardens, Batemans Bay. With wife Carolyn, he planted and observed isopogons and petrophiles in their garden at Glenduart near Moruya on the NSW South Coast. They experimented with different locations in the garden and with container planting and had many notable successes. In one section of the garden, plants of isopogon and petrophiles were grouped together producing a spring display that knocked our socks off (an early stage is pictured below). Importantly, Mark reported all their observations and we all learned from their experiences growing plants, striking cuttings and raising seed. Memorable contributions include Mark's comments on self-seeding in the garden path, on the ancient feel of *P. sessilis*, on the impact of severe pruning on *I. anemonifolius* and *I. anethifolius*, and his 'bog' method for raising seed.

Mark was always quick to offer advice and assistance to the study group. Having developed a method for taking high-definition photographs, he proceeded to photograph the floral elements of many isopogon species in perfect detail, no matter how minute. He also began work on a digital key for isopogons and petrophiles. He wrote articles for the newsletter, provided comments and feedback, and gave us much encouragement over the years.

Mark's wicked sense of humour was legendary. Our local town is Ulladulla but he insisted on calling it 'Neverdulla'. He would often write to us as study group leaders with humorous questions and observations. Here is a selection from Mark…

We seem to have a problem with our P. sessilis! We have these cone shaped bud thingies all over them and some are opening into flowers. How do we stop such things from occurring in our IP garden?

P. sessilis flowers. But they have no stalks!
[with a photo of the flowers, referring to the meaning of sessilis i.e. without stalks].

Arrggghh!!! How can I tell Phil and Catriona that my I. latifolius won't stop flowering?
[in response to our advice that this species can be a shy flowerer].

Can you advise how to get this I. latifolius to flower better please?
[with a photo of a beautifully flowering I. latifolius].

Tried to take a pic of our bottle tree and this b____ thing photo bombed us
[with a photo of an abundantly flowering I. formosus].

The problem with I. formosus is that they are so over the top dominating the garden and hiding the grevilleas
[with a photo of massed I. formosus plants].

We never succeeded in moving Mark on from his beloved grevilleas, or 'grevs' as he called them, but his support and contribution to the Isopogon & Petrophile Study Group will long be remembered, used and appreciated. Thanks for everything Mark.

Financial Report

Total 31/10/2023		$2,429.06
	Bank balance $2,325.62	
	Cash on hand $103.44	
Donations/income		$195.00
	Australian Plant sales $45.00	
	Yarra Yarra APS $150.00	
Total 3/04/2024		$2,624.06
	Bank balance $2,520.62	
	Cash on hand $103.44	

Donations are welcome

ANPSA Isopogon & Petrophile Study Gr
Bendigo Bank BSB 633-000
Acct 156858730

Glossary (Morphology matters p. 20)
Alternate: one after the other along an axis; not opposite
Anther: the pollen-bearing portion of the stamen
Bract: a reduced leaf or scale, typically one at the base of a flower; floral bract.
Cohering: forming a whole
Cone scale: a floral bract from which a flower emerges; hardens and turns grey after flowers drop.
Imbricate: where one organ, or series of organs, overlaps another organ or series of organs; as in roof shingles
Inflorescence: a flower cluster; flower head
Involucre: a whorl or overlapping series of bracts, typically around the base of a flower head.
Nut: a hard, indehiscent (does not open at maturity), one-seeded, fruit, typically with an outer shell
Ovule: the body which, after fertilization, becomes the seed.
Perianth: the outer, non-reproductive part of the flower; collective term for tepals
Rachis: The principal axis of an inflorescence.
Stamen: pollen-producing structure comprised of the anther and filament (stalk); the male reproductive organs.
Stigma: part of the pistil (female part of flower comprised of ovary, style and stigma) at the tip of the style receptive to pollen
Style: a slender stalk connecting the stigma with the ovary
Taxa/taxon: a discrete taxonomic unit.
Tepal: segment of the perianth (not recognised as a petal or sepal)