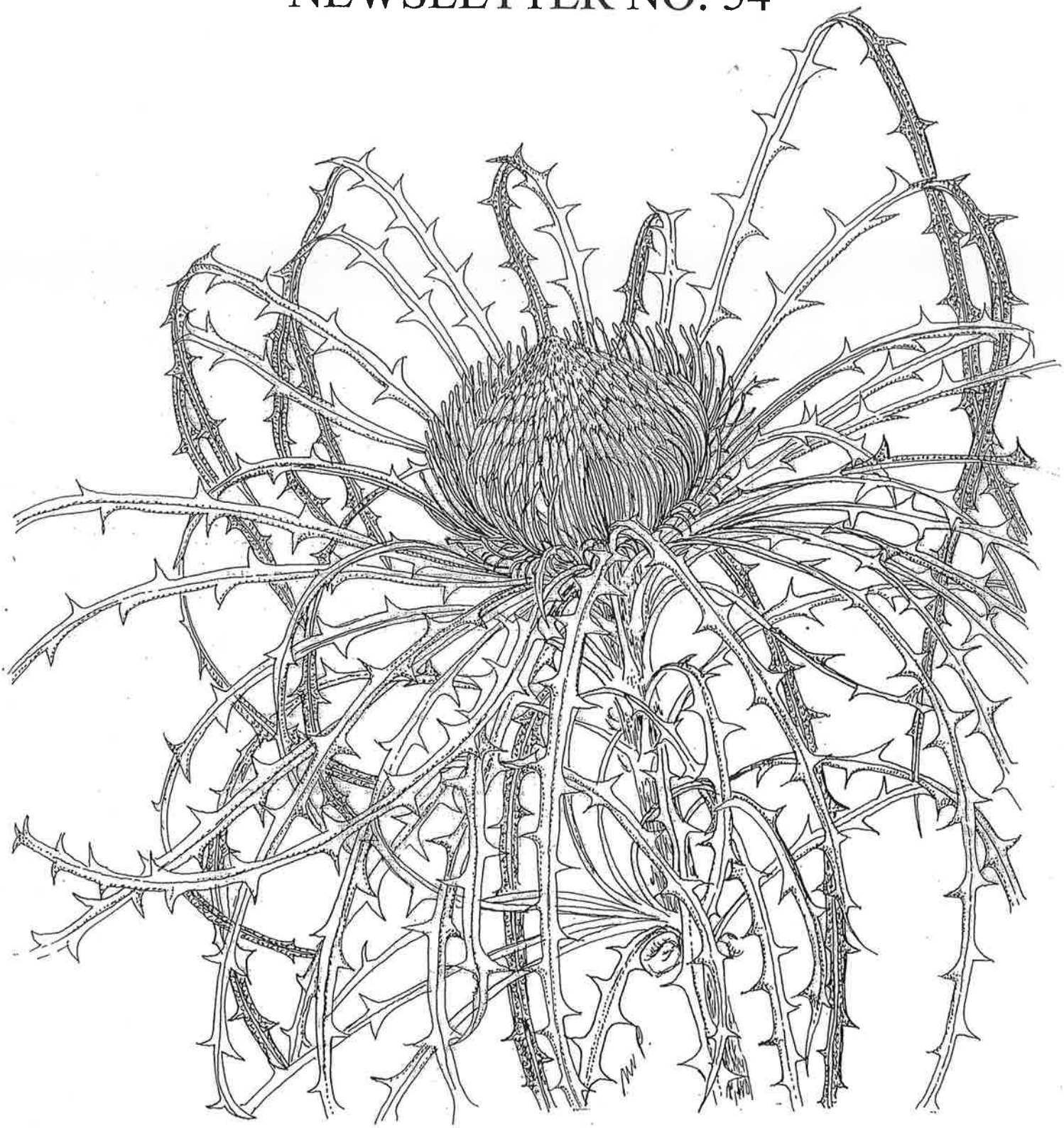
DRYANDRA STUDY GROUP NEWSLETTER NO. 54



Dryandra longifolia subsp. *archeos*

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ASSOCIATION OF SOCIETIES FOR GROWING AUSTRALIAN PLANTS

***Dryandra longifolia* subsp. *archeos*.** Flowering earlier than the other subspecies, (in March in my garden), this is a bushy shrub to 2m. The involucral bracts surrounding the bright yellow, terminal flower heads are strongly recurved unlike those of the other two subspecies. The leaves, as well, tend to be more inwardly curving.

DRYANDRA STUDY GROUP

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Welcome to the new year and our first Newsletter.

Since our last Newsletter, I have been doing some reading on what I call the "new taxonomy" ie the use of new techniques such as cladistics and molecular analysis to assist with classification of plants. I can't say that I am any closer to understanding much of it but I am at least beginning to "get a handle on" how the new and old practices relate to each other. I have written a short piece later in the Newsletter with some further thoughts but as the professionals (botanists, biologists, taxonomists) are seemingly split on just how far to go with the new taxonomy, I doubt whether the issues raised with the proposed inclusion of *Dryandra* into *Banksia* will be sorted out any time soon.

On this matter, I am very grateful to Dr. Kevin Thiele, Curator of the Western Australian Herbarium and co-author of the paper which formalized the proposed incorporation, for taking up the challenge of preparing an explanation in layperson's terms of the reasons behind their thinking and for so ably setting the background to much of the new way of looking at plant classification. I would ask all members of the Dryandra Study Group to read Kevin's paper and if you have comments or questions, please send them to me or Margaret and we will include them in the next Newsletter.

Thanks to everyone who contributed information for the Newsletter and to David Lightfoot for printing the colour page. I was fascinated with Margaret's account of her struggles to locate plants of the rare *D. longifolia* subsp. *archeos* and in so doing, markedly extended the known range of the species. It was great to see that Jean and Fred Hort are continuing with this work and have recently located two new populations of the uncommon *D. meganotia* relatively close to Perth. It seems that with so many WA plants, the more you look, the more you find. Liesbeth reports on more success with flowering Australian banksias and dryandras in her glasshouses in the Netherlands and with germinating dryandra seed while I give an update of dryandras I am growing here in Ocean Grove. As some plants are now over 25 years old, I think that it is true to say that once established, dryandras can be hardy and long-lived. I was also delighted to receive Phil Trickett's update of his grafting trials and Catriona Bate's article on the dryandras they are growing in their garden in Canberra, surely an area that does not automatically spring to mind as being good for dryandras. It was particularly pleasing to see that Phil appears to have solved the dieback at the graft union problem which had plagued earlier work. Finally, Margaret has written a few comments following Kevin Thiele's article and I have put down some thoughts on classification and the current *Banksia/Dryandra* controversy.

Happy *Dryandra* growing

Tony

Tony

Dryandra longifolia subsp. *archeos*

This is one of my favourite taxa – one that I have grown successfully here in Denmark.

My first sight of *D. longifolia* subsp. *archeos* in the wild was in May, 1996, the year Alex George's revision of *Dryandra* was published. I had managed to seek out most of the fifty-odd taxa which had been undescribed up until then as well as subsp. *longifolia* (at Cape le Grande National Park) and subsp. *calcicola* (just west of Esperance). Alex had given me photocopies of the undescribed herbarium specimens and their locations, some of which were rather vague, so looking for them all was quite an adventure, at times.

D. longifolia subsp. *archeos* had only been collected on Mount Ragged, 150 km. east of Esperance in Cape Arid National Park, accessible only with a 4WD vehicle. I got an opportunity to go there when Brian Moyle offered to take me. I contacted the ranger, Alan Rose who told me that only one flowering specimen had been collected recently and that he had just been to Mount Ragged and that none of the plants were flowering since the fire of four years previously. This was not good news but I was still determined to go and look for myself. Alex had provided locations for the plants – one on the very top of Mount Ragged and the other about a third of the way up on the southern side.

We stayed at Duke of Orleans Bay west of the National Park and left early in the morning, eastwards on Fisheries Road which crosses the National Park north of Mt. Arid and goes to Israelite Bay. We turned north on Balladonia 'Road' which goes straight to Mount Ragged. For the whole length of the track it is visible straight in front in the distance, rising above the flat plain The closer we got, the steeper it looked until we got there, when it didn't look quite so far to where we wanted to climb.

Mount Ragged is a steep-sided, pre-Cambrian ridge with a wave-cut platform on the southern side, similar to the Barrens in the Fitzgerald River National Park but further from the coast. The track was very rough with deep white sand, gravel, corrugations, mud puddles, clay puddles, limestone rocks and now and then a few good smooth stretches. The number of flowering plants we saw astounded us. We had to keep stopping to photograph and collect specimens: three verticordias, a boronia, acacias, banksias and a lovely red styphelia, *S. hainsii*.

We started climbing a sharp ridge of quartzite towards the first location. We found a dryandra in flower which I later identified as *D. armata* var. *ignicida*. We soon found small plants of *D. longifolia*. Some had what appeared to aborted buds. Except for the mallee eucalypts most of the vegetation was regrowth from seed. The fire must have been intense as the whole area had been burnt even where there were large boulders. I was hoping to find a dryandra that had escaped the fire among the rocks, but I didn't. It looked as though our trip had been in vain, after all but, thinking that the eastern face of the ridge might be a better prospect we made our way around to it and Brian found the first plant in flower. One plant had several flower heads in various stages and made a good photo. The limbs on the tips of the buds had rusty hairs like the

subsp. *calcicola* I had in my Perth garden. We also found a plant with all-yellow flowers.

Alex had named the taxon subsp. *archeos* as it is the first dryandra to greet the dawn and we had proved that the first plants in the population to flower were those that faced the east.

In late May – early June 2000 we made a return visit. The direct route, Balladonia Road was impassable due to heavy rain earlier in the year and we had to take the long way round via Parmango Road. This entailed driving more than 200 kms further, some of it on rough tracks, first to the east and north of our objective, then approaching it from the north. North of Mount Ragged, the sandplain and heathland vegetation gives way to woodlands where saltbush and bluebush dominate in the understorey.

On this occasion we didn't have to climb as far as the quartzite ridge to find *D. longifolia* subsp. *archeos* in flower. *D. armata* var. *ignicida* was flowering well, too with some flowers a lovely deep pink. While photographing some hakeas at the car park at the base of Tower Peak we discovered *D. longifolia* subsp.*archeos* there as well. It had taken all morning to get there so finding the dryandras so soon was a bonus.

The following day we found our way to Mount Arid, on the coast and found *D. longifolia* subsp. *longifolia* growing in dense scrub around the base of the granite dome. That afternoon we tried to reach what seemed to be an interesting place, on the map – The Diamonds Hill. The track was in such an atrocious condition that we were forced to turn back before reaching the track that led off Fisheries Road to the hill. We resolved to return another time.

In 2001 we returned to Mount Ragged with Keith Alcock and Paul Kennedy who was interested in seeing some of the hakeas he hadn't seen in the wild especially some that grow at the base of Mount Ragged. I had noted them the year before and also spotted what Paul confirmed were hybrids.

The chance to try for The Diamonds Hill came in August, 2002 when Brian took me back to Cape Arid and Esperance to collect and compare the three subspecies of *D. longifolia.* (See Newsletter no.44)

The day we set out for The Diamonds Hill was cloudless and warm but the wind was ferocious. There was a storm warning for the south west and a forecast for Esperance of 'rain increasing'. There were still many 'water jumps' on Fisheries Road and by-passes around by-passes but not quite as bad as in 2000. The worst boggy patch was where we had decided to turn back the last time! We found the unsigned track to The Diamonds Hill, thanks to our good maps and Brian's GPS. The track, though obviously un-used for some time, was dry and easy to negotiate. It petered out after turning east and then north, at about the middle of the eastern side of the hill. We had expected that the track would finish at the top. A gravel pit, marked on the map is apparently long since overgrown as there was no sign of it.

Keeping an eye out for rain clouds, as it could have been risky returning along Fisheries Road after heavy rain, we started to walk up the slope where we were thankful to be sheltered from the wind. After a short distance we found *D. longifolia* subsp. *archeos* – masses of it! When we'd noticed that the boulders higher on the hill and the scree slopes were quartzite we were hopeful of finding it there. We realised that this area must be pretty much unexplored botanically. No-one could possibly miss seeing the dryandra – it appears to be more prevalent than at Mount Ragged. As we climbed higher, the plants became more numerous and eventually, as I'd hoped we found a few plants in late flower. While photographing the *D. longifolia* I noticed a strange looking dryandra next to it. Flowers were finished and the previous years seed heads had grubs in them but we realised that it must have been a hybrid of *D. longifolia* subsp. *archeos* and *D. armata* var. *ignicida.* The year before, at Mount Arid, Keith discovered a presumed hybrid, subsp *longifolia* X *D. armata* var. *ignicida* in a population of subsp. *longifolia.*

We got to about half-way to the top then, reluctantly as rain clouds appeared, we had to leave. As we were driving back we noticed two large rocks at the top were almost identical in size and shape – like two diamonds lying on their sides. We wondered whether this explains the name of the hill.

In April, 2003 we took Don and Joy Williams to Mount Ragged. Once again the direct route was impassable and we had to take the long way round which didn't leave much time at Mount Ragged and meant that we didn't get to The Diamonds Hill.

There is a smaller hill, Mica Hill to the south east of Mount Ragged not far off the track that goes to Israelite Bay and I would like to explore that. I was told that a track had been put through that almost reaches the hill so on my next trip, I was hoping to get there.

In August 2004, with Paul Kennedy, John Cullen and Kevin Collins I made my most recent trip. We went to Mount Ragged and then headed towards Mica Hill. It was getting late as we had spent a lot of time on the way botanising and we didn't find a track to the hill. We continued on towards Israelite Bay and by the time we reached the coast on a very rough track, it was dark.

The next day we went to The Diamonds Hill where we discovered that the track had been graded and a clearing made for parking. We reached the top this time and from there could see that the track continued on in the direction of Mica Hill. Oh well…next time!

On the way to Duke of Orleans Bay where we stayed, Kevin had found *D. longifolia* subsp. *calcicola* growing on a limestone headland at Quagi Beach about 55 km west of Esperance. On the way home he took me to see it. There were many different plants there that were quite prostrate as well the dryandras. This location has extended the range of this taxon much further west. I asked friends who often camp at Shelly Beach 15 km east of there to look for it and they have reported it there as well. It could be growing on limestone cliffs on other parts of the coast between there and Esperance but access is difficult except perhaps by sea.

Before coming to Denmark I had propagated a plant of *D. longifolia* subsp. *archeos.* together with other plants, mostly dryandras and with some I lifted and potted up from the garden I took them to the Banksia Farm at Mt. Barker for Kevin to look after while my house was being built. They all did exceptionally well and I planted them out in 2005. This year subsp. *archeos* flowered for the first time. The first flowers opened on the eastern side of the plant in March, then in April a few on the western side and finally, in June and July on the northern and southern sides. At the moment there are four seed heads that are surrounded by the small, prickly branchlets that appear when the seed is developing.

Margaret Pieroni 5/12/07

About the Photos

Dryandra bipinnatifida subsp. ***bipinnatifida.*** This is one of several plants that I moved successfully from my Perth garden to Denmark with a year at the Banksia Farm, in between. As soon as I lifted the plant which had been struggling to grow for five or six years, it began to put out new growth and eventually flowered last October while still in the pot.

Subsp. bipinnatifida grows in Jarrah/Marri forests in the South-West of the state and south and just east of Perth. Subsp. *multifida* occurs to the north between Muchea and Eneabba.

The form of subsp. *bipinnatifida* pictured in *The Dryandras* was from Kalamunda, east of Perth, on the Darling scarp. It has broader leaf lobes than others further south. Flower buds are formed at the ends of underground branches and emerge from the soil to flower. The bracts close over the spent flower heads.

Few people have observed this species in flower. The flower heads often disappear mysteriously overnight. My theory is that they are eaten, perhaps by 'Bobtails' – Shingleback Skinks.

In both subspecies, the colour of the inside of the bracts is usually a pinkish beige but occasionally, as with this one, it is red/brown.

In *The Dryandras*, I meant to include a photo, (not this particular one) of the Eurardy form of ***Dryandra fraseri*** var. ***ashbyi***. I sent a slide to the publisher but forgot to indicate a place for it in the page layout.

The typical size and shape of this form is similar to var. *oxycedra* but at Eurardy station in the middle of a paddock, was this huge specimen about 2.5m tall and 5m wide. The earth under the bush was riddled with rabbit holes which probably caused the death of the plant soon after I photographed it.

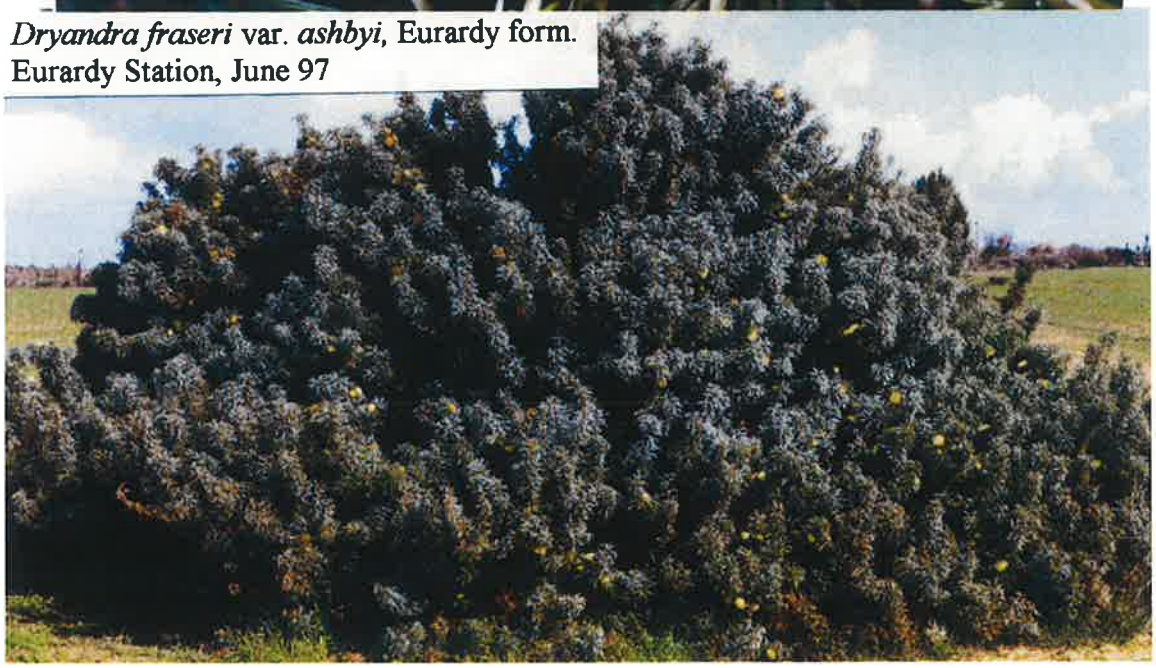
As can be seen from the drawings in the book, the leaf and seed follicle shapes and sizes are different from typical var. *ashbyi* from further south, near Geraldton. Towards Kalbarri and Eurardy and across towards the coast, the plants become progressively taller.

Var. *ashbyi,* unlike var. *oxycedra*, has a lignotuber and re-sprouts after fire.

Margaret Pieroni 10/11/06

Dryandra bipinnatifida subsp. *bipinnatifida.*
In cultivation, Denmark, October 06

Dryandra fraseri var. *ashbyi*, Eurardy form.
Eurardy Station, June 97



Notes from members

From Liesbeth Uijtewaal, Neer, Netherlands, December 2007

The dryandras are doing quite well over here. *D. nobilis* and *D. drummondii* ssp. *hiemalis* are almost in flower, they must be waiting for the brighter weather to waken up. Fortunately we have the shortest day behind us which in general is the sign for the plants to come back to activity. Can't wait!

I planted the Dryandra seeds that Margaret sent me in October. As usual the germination rates were rather low but of *D. bipinnatifida* ssp. *multifida,* 7 out of 7 germinated rather quickly and they're all growing well. *D. praemorsa* var. *splendens* had a score of 6 out of 7 which is very good too, most also growing well. I do hope they'll all develop those lovely pink flowers.

Banksia telmatiaea and *B. scabrella* are in flower now, lovely to see this new -to me that is- type of flower. All those banksias are so different, lovely.

There's one of the 25 or so *D. erythrocephala* seedlings (both varieties) left over, it's growing slowly. The other ones just dropped dead, one by one. I wonder whether I will get the remaining one to flowering stage.

(You still have amazing success growing "our" plants in glasshouses, Liesbeth. *D. erythrocephala* can be very "touchy" at the seedling stage and potting and soil mixes must have excellent drainage. Ed.)

From Fred and Jean Hort via Margaret, January 2008.

(The following was extracted from several emails that Fred and Jean had sent to Margaret, along with some great photos of the plants and seeds in close up, and in their natural habitat. There seems little doubt that they are *D. meganotia* and that the discoveries have markedly extended the known range of this rare (Priority Three) plant. Previously thought to be restricted to an area of the Wheat Belt known as Great Southern (hence its name, from the Greek *megas* (large) and *notios* (southern)), it has subsequently been discovered further north, near Wandering and now near Mt. Cooke, close to Perth. Jean and Fred Hort are the discoverers and collectors of the type specimen of the recently-named *D. prionotes* (see NL 44, pages 2-4) and have been exploring and discovering new plants and new populations for many years, and still get great excitement out of their discoveries. It is great to have this information on the extension of the range of *D. meganotia.* Ed.)

"I collected *Dryandra meganotia* just west of Albany Hwy - mid way between Sullivan Rock and Mt Cooke. There were 186 mature plants in a shrubland fringed by jarrah and marri woodland. The shrubs were erect/spreading to 1.5m high and some were up to c. 2.2m wide. They were single stemmed and generally branched out from near the base. The plants were crowded with bundles of leaves each to c. 7cm long. The seeds we found were in tiny, hairy follicles which are typical of *D. meganotia.*.

Today, Sunday, we found another population of *D. meganotia,* 1.5 km south of yesterday's patch. We particularly noticed that the plants again were single stemmed and that they branched from above ground level - definitely not suckering shrubs. Plants were to 1.8m high and up to 2.4m wide. We counted 70 mature plants here, growing on and around granite outcrops. About double that amount were burnt out. Among the blackened stumps we saw a few seedlings emerging."

From Tony Cavanagh, Ocean Grove, Vic.January 2008

It is quite a while since I reported on my dryandras, now somewhat diminished in number after nearly 10 years of drought or below-average rainfall and continuing growth of larger shrubs and trees which have tended to shade the garden. I am fairly certain that this will be my last report on one of my oldest *Dryandra, D. baxteri*, one of my favourites with delightful soft foliage and exquisite flower heads when viewed close up. It is over 23 years old but has been steadily dying over the last 6 months and the remaining branches are looking anything but happy. Fortunately, I have a dwarf form grown from seed supplied by Kevin Collins, which is slow growing but I hope will flower in the next couple of years.

I have always contended that many dryandras are hardy and long-lived if you can get them established in reasonably good conditions. Unfortunately the converse often applies – if the conditions are not right (too much shade, soil too dry, too much competition from other plants etc), then it can be extremely difficult to get them going at all. I still have *D. brownii, D. proteoides, D. longifolia subsp. longifolia, D. nervosa, D. cuneata, D. cirsioides* and a dwarf form of *D. lindleyana* (subspecies unknown) which are over 20 years old, still alive but apart from *D. longifolia, D. nervosa* and *D. cuneata,* they no longer flower as their garden beds are shaded or overrun with tree roots. I also used to grow successfully *D. fraseri* var. *fraseri* but my original plants died several years ago and I cannot get another one established (or at least grow, it is about 20 cm high and over 4 years old!). On the other hand, I have found that *D. formosa* can be established in dry shade as long as you are prepared to give it some water over summer, and have perhaps a dozen plants around the yard in all types of situations.

The following table includes nearly all my dryandras worth talking about with details such as approximate size and age and whether it has or currently flowers. Those marked with an asterisk* are what I regard as successful in my area. Wherever possible, I have tried to give them as much sun as possible when planting out and preferably decent soil, but this can be problematic when the topsoil is less than 30 cm deep over clay, so raised beds are often the order of the day. Once they are established after having been watered in over their first summer, they are generally left to fend for themselves except for small plants which are slow and which may receive extra water as required.

Species	Approx. size H xW (m)	Age yrs (approx)	Flowering currently	Comments
anatona	Pot	1	N	Have not been able to keep alive in the garden, cutting grown
*baxteri**	1 x 2	>23	Y	Very sprawling, very unhappy and probably dying
*brownii**	0.5 x 1.5 (old plant in shade)	6->23	Y (rarely)	Two plants, youngest 0.75 x 1, beautiful foliage
*calophylla**	Various	2-15	Y	Prostrate plant, several plants growing well
*carlinoides**	0.5 x 0.5	5 (several)	Y	Cutting grown, one of the more successful northern species
catoglypta	0.5 x 0.3	6	N	Very slow but healthy
conferta	0.8 x 0.4	5	N	In very shaded position, slow growing but healthy
*cuneata**	1.5 x 2.5	>25	Y	Looking tired, flowers poorly. Also have the prostrate form but this is very slow growing
drummondii s. *drummondii**	0.75 x 1	>23	Y	Best flowering this year
*foliosissima**	0.75 x 1.5	10	Y	Sprawling shrub, slow to flower
*formosa**	Various	2-15	Y	Flowers very well, often for long periods, as late as Dec.

fraseri v. *ashbyi**	1 x 0.8	10	Y	Two plants, flower well
insulanemororecincta	0.4 x 0.3	5	N	Very slow, too much competition from tree roots
ionthocarpa s.*ionthocarpa**	0.5 x 0.75	5 - 15	Y	Flowers hidden, suffers from death of leaves
lepidhoriza	0.5 x 0.5	8	Y	Slow growing, flowers spasmodically
lindleyana s. *lindleyana**	0.4 x 1	12	Y	Grows well in partial shade, have several plants
longifolia s. *longifolia***	3 x 3	>23	Y	Most successful species, 4 plants, several cutting grown
*nervosa**	1 x 1.5	8-23	Y	Several plants, hardy and long-lived, flower well
nivea var. *nivea**	0.75 x 0.5	15	Y	Have orange and red flowering forms
*nobilis**	3 x 3	15	Y	Hardy, strong grower, in very dry situation
plumosa subsp. *plumosa**	1 x 0.5	12	Y	Hardy, great foliage
porrecta	0.5 x 0.75	8	Y	Occasionally flowers, growing slowly
praemorsa v. *praemorsa*	2 x 2	Various	Y	Not long lived for me, these are self sown
praemorsa v. *splendens**	2 x 2	15	Y	Fairly good pink flowering form
proteoides	1.8 x 1	>23	N	In very dry, shaded position
quercifolia (pink)	1.5 x 1	6	Y	Strongest form of this plant which usually I find difficult
sessilis v. *flabellifolia**	1.5 x 2	20	Y	Unusually small, in very dry area
sessilis v. *sessilis**	5 x 4	>25	Y	Very hardy, long flowering
subulata	0.4 x 0.2	6	Y	Lovely grass like foliage

Some background to the proposed merger of *Dryandra* into *Banksia*

Kevin Thiele
Western Australian Herbarium

A paper I published recently with Austin Mast from the University of Florida has created controversy among native plant and wildflower enthusiasts. Mast and I have recommended that the two well-established genera *Banksia* and *Dryandra* should be merged into one genus (which under the International Code of Botanical Nomenclature must be the older genus, *Banksia*). To effect the merge, we created new names for all *Dryandra* species in *Banksia*.

Not surprisingly, this move has caused a stir in the community, some of which is reflected in articles and opinion pieces in the last issue of this newsletter. The editor invited me to respond, and to explain to this readership the research and thinking behind our paper.

The implicit question is clearly this – why on earth would anyone do such a clearly nonsensical thing as to sink *Dryandra* into *Banksia*, when they are such obviously good genera?

Tony Cavanagh, in the last issue of this newsletter, is right when he complains that the 'new taxonomy' seems complex. Like many people, he seeks a return to 'the old days' when anyone with a handlens could work out and understand the relationships of plants. But the differences between the 'old' and 'new' taxonomy is also a fascinating story, some of which I'd like to tell in this article.

I plan to approach the *Banksia-Dryandra* issue in several stages, firstly with an explanation for some of the reasons why taxonomists 'keep changing the names', followed by a short history and philosophy of classification, and finally with a discussion of the reasons behind the *Dryandra* change itself.

Why names change

There are several main reasons why taxonomists from time to time need, or choose, to change the name of an organism such as a plant.

Firstly, the naming of plants is covered by a set of rules – the International Code of Botanical Nomenclature – which sets out how to correctly name plants and how to resolve cases where two or more names have been used for one species. It sometimes happens that applying the rules requires us to change a name.

For example, if a species named by one botanist turns out to have been previously validly named by an earlier botanist, then the Code stipulates that (except under certain conditions) the earlier name must replace the later name. This is a sensible rule when you think about it, as it gives due recognition to the first person who named a particular species, which is only fair.

Secondly, and more importantly for the purpose of this article, names may change because our knowledge grows. For example, when Linnaeus – the father of taxonomy, whose tercentenary was celebrated in 2007 – first described the world's grasses, he placed them all into a single genus, *Poa*. As more and more grasses became known, it became clear that this was simply silly – imagine if all the world's c. 9000 species of grass, from bamboos to spinifex, were called *Poa*! It wouldn't be a very useful taxonomy.

Interestingly, the fact that names often need to change when our knowledge grows is actually a problem caused by the very system of naming for which Linnaeus is famous.

Linnaeus formalized the binomial naming system with which we are familiar, in which every species has a double-barreled name (such as *Poa annua*), much as do names of people (e.g. John Smith) and of many things (e.g. apple pie). This was a brilliant innovation. Not only does it make it relatively easy to create a unique name for every species, but it also encodes handy relationship information in the name. That is, encoded in the name *Poa annua* is the fact that the species in question belongs in the genus *Poa*. This makes it easy to remember where a species *fits* as well as what it *is*.

But here's the nub of a problem – if the name encodes where a species fits, then you need to change the name if you decide that it fits better somewhere else. I'll return to this issue later, as it lies at the heart of the *Banksia-Dryandra* issue. As an aside, I expect that Linnaeus himself would have been mortified to be told that his binomial system causes problems, largely because he

would have regarded that once a species was named and placed into a genus by Linnaeus then it would never need to be renamed into another genus by anyone else!

So, names sometimes need to change when our knowledge – our understanding of the relationships of species – grows. Taxonomy and systematics, like any science, evolves. Who would tell dream of telling physicists that their new understanding of the Universe is too complicated so we should stick with Newton. It doesn't make sense. Similarly, taxonomy grows and changes, and because names are the core of taxonomy, I believe that it would be tragedy if they were to stay the same and not reflect new knowledge and understanding.

Why taxonomies change

So why do taxonomists sometimes change their minds about the relationships of species? To understand this requires us to understand the philosophy and practice of taxonomy and systematics.

What taxonomists and systematists attempt to do is no less than to understand and describe, in great detail, the patterning of all life. This enterprise began well before Linnaeus, when early Greek philosophers such as Theophrastus (370-285 BC) began classifying plants.

Taxonomy began with the obvious observation that some species naturally group with others. Any schoolchild can tell you that a mouse and a rat 'go together', and both are clearly very different from a cow. Similarly, *Dryandra nivea* and *D. brownii* clearly fit together, and both are obviously different in many ways from *Banksia coccinea*.

For the vast majority of our history, from Theophrastus through Linnaeus and right up to the mid 20th Century, taxonomies were constructed by simply putting together things that clearly 'go together'. In the early days, the thinking was very simplistic – for example, before Linnaeus all 'trees' were classified together, separate from all 'shrubs' and 'herbs'. Linnaeus introduced a more sophisticated method, grouping plants based on the numbers of stamens and pistils. The French botanist Antoine Laurent de Jussieu used a more sophisticated approach still, arguing for what we would now call a 'whole-of-evidence' approach – assess *all* the characteristics (of leaves, flowers, fruits etc), then group like with like according to overall similarities and differences.

But there's an interesting difficulty with the approaches described so far. Plants are complex organisms, with many characteristics. Suppose one taxonomist believes, from observation of certain characteristics, that species A and B naturally 'fit' together into one genus, and species C and D naturally form a second genus. Suppose a second taxonomist believes, from observation of perhaps other characteristics, that it works better to put A and C into one genus and B and D into another. How could we choose which was the better taxonomy? We would have to either decide which arrangement worked better for us, or choose to believe the more respectable and important taxonomist. Both are very subjective and unsatisfactory judgments.

Without a clear underpinning idea for *why* some things 'go' with others, the question of which classification is better is probably meaningless anyway. It's like asking which is better, a taxonomy that groups cups with bowls and plates with saucers, versus another that groups cups with saucers and plates with bowls. There is no reason to suppose that either is better than the other; both are equally valid (and equally meaningless).

Taxonomy of organisms, fortunately, is different from taxonomies of crockery or stamps, because it does have an underpinning framework, provided by Charles Darwin when, in the *Origin of Species*, he introduced the concept of evolution by descent with modification.

Darwin convinced scientists that all living organisms were part of a single 'family tree' of life (a phylogeny). This is a grand idea and one of the most important unifying concepts in biology. It explains beautifully, amongst other things, *why* mice and rats are similar (because they share many features inherited from a recent common ancestor), and cows are fairly different (because the common ancestor of rats, mice and cows is more distant). Because most of us simply accept evolution as self-evident now, it's sometimes hard to grasp the revolution that Darwin brought to our thinking about nature.

Taxonomists, after Darwin, gradually accepted the idea that the purpose of a classification is not simply to group superficially like with like, but to classify organisms in a way that reflects their evolutionary relationships in some fashion. Further, Darwin provided a framework for choosing between classifications – because organisms evolved, and because there appears to be only one tree of life, some classifications (those that more closely reflect the patterns of evolution) are better than others.

For many years until the middle of the 20th Century, taxonomists accepted the idea that classification should reflect evolution, but really had no idea how to put it into practice. There was a vague hope that grouping organisms according to overall likeness would result in a classification that reflected in some way the tree of life. But with no way of testing the fit, if two taxonomists came up with different classifications, you still pretty much believed whichever you preferred. Darwin had provided taxonomists with an underpinning framework, but no way of applying that framework to the problem of taxonomy.

A breakthrough came in the 1950s when a German entomologist, Willi Hennig, developed a method for mathematically *calculating* the most likely family tree or phylogeny from the patterns of characteristics in a group of organisms. Hennig's method, now called *cladistics* (and other similar methods developed in the last few decades), allows taxonomists to find a way through the vast array of similarities and differences that occur in any group of organisms, and to work out a best fit with the tree of life.

It's outside the scope of the present article to explain cladistic methods and related analysis techniques in detail (it *is* possible to explain cladistics simply and I may do this in a later article). The most important point is that these methods, at least in theory, are rigorous, repeatable and produce classifications that can be tested, rather than vague and untestable ideas as has been the case in the past. It was these methods that Austin Mast and I used to try to understand that branch of the tree of life that contains the banksias and dryandras.

The evolution of Banksia *and* Dryandra

To understand the significance of the results that Mast and I obtained, consider Figure 1 which shows, I believe, what most taxonomists would have drawn twenty years ago if they'd tried drawing a family tree of banksias and dryandras. They would almost certainly have imagined two branches on the tree of life, one comprising all the *Banksia* species and one comprising all the *Dryandra* species. (The details of branching patterns within the two main genera is of no relevance here, but it probably would have followed the overall classifications of Alex George.)

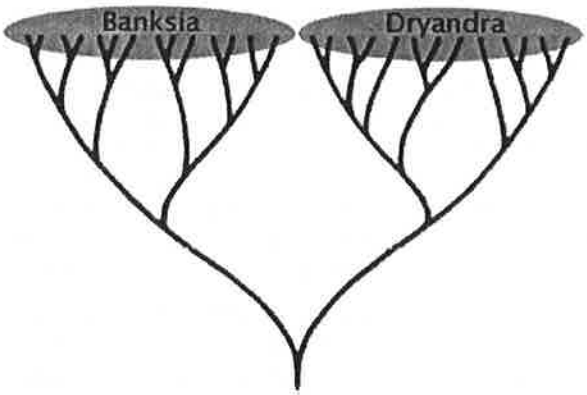


Figure 1. The traditional understanding of the relationship between *Banksia* and *Dryandra*

By contrast, when Mast and I used cladistic methods to investigate the same question, we got the surprising, and very interesting, result shown in Figure 2. Our studies suggest that *Dryandra* is a branch that springs *out of* the greater *Banksia* branch, instead of being a sister branch. That is, dryandras are modified and specialized banksias.

Look at Figures 1 and 2 again in terms of ancestors and descendants (shown by arrows on the figures). If Mast and I are correct, then *Dryandra* comprises all the descendants of the ancestral *Dryandra* species (the one that first evolved from a *Banksia*). In modern taxonomy, such a group is called *monophyletic.* But *Banksia*, as traditionally understood, comprises only some of the descendants of the ancestral *Banksia* (that is, only those that haven't subsequently evolved into

dryandras). Such a group is called *paraphyletic*. Viewed in this way, the two traditional genera are not equivalent – one is a monophyletic group and the other is a paraphyletic one.

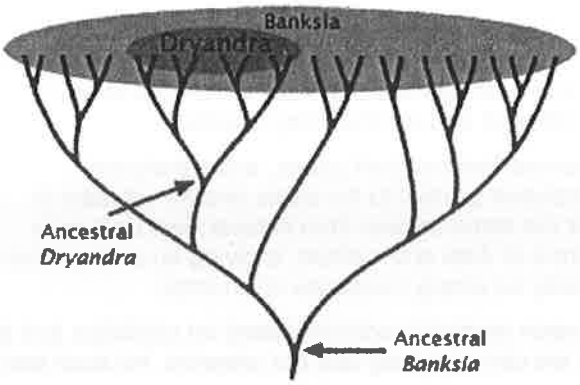


Figure 2. The new understanding of the relationship between *Banksia* and *Dryandra*

This difference (between what we now call monophyletic and paraphyletic groups), was of great interest to Greek philosophers at the time of Plato, who pointed out to the Greeks a problem in the way they thought of themselves and of others. Many Greeks regarded that there were two classes of people, Greeks and Barbarians. Plato pointed out that these two classes are different in kind. 'Greeks' is a true class, because it comprises all people of Greek descent. But 'Barbarians' is not a class at all, as it comprises the class of all people minus the class of Greeks. It's a grouping that can only be defined by what it's not rather than what it is.

Plato's problem with a group like 'Barbarians' is that some members of the group are more closely related to members outside the group than they are to other members inside the group – some 'Barbarians' are more closely related to the Greeks than they are to other 'Barbarians'. This makes nonsense of the 'Barbarian' group.

A little reflection shows that this is exactly the same as the situation with *Banksia* and *Dryandra*. Because dryandras evolved from inside *Banksia*, some banksias are more closely related to dryandras than they are to other banksias. To most modern taxonomists, this makes the old *Banksia* an untenable group.

Returning to Figures 1 (the old way of imagining *Banksia* and *Dryandra*) and Figure 2 (the new understanding), it's interesting to ask: why did we imagine incorrectly? Figure 3 is another way of drawing the new understanding. In this figure, *Dryandra* still emerges from within *Banksia*, but since evolving it's very much gone its own way and has diverged a lot in morphology. It's like a wild branch that, once evolved from *Banksia* goes off on its own. This is why we've always thought of *Banksia* and *Dryandra* as two quite separate genera. We've been tricked by the changes that have occurred on the *Dryandra* branch since it evolved from its *Banksia* ancestor.

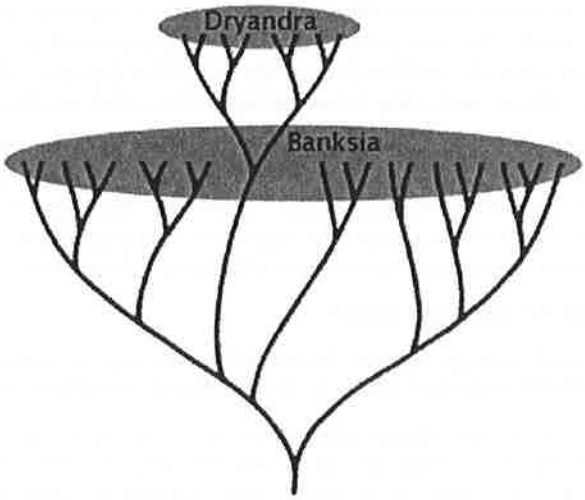


Figure 3. Another way of looking at the relationship between *Banksia* and *Dryandra*

What to do with Dryandra?

In the discussion above I've tried to explain what we believe is the true pattern of relationships of the species in the *Banksia-Dryandra* branch of the tree of life, derived from our cladistic analyses. To reflect the new knowledge, we have chosen to put *Dryandra* in its rightful place, as a specialized offshoot within the *Banksia* branch. Unfortunately, under the rules of the Code and under the new, widely accepted tenet in taxonomy that we should name only monophyletic branches in the tree of life, this requires that we change all the *Dryandra* names.

We understand that many people will question, and criticize, what we've done. To help discussion, I believe there are three possible criticisms – firstly, that the cladistic methods used in our analyses are flawed, secondly, that the information we used for the analyses is incorrect or inadequate[1], and finally that even if the answer is correct, we should still not have merged *Dryandra* into *Banksia*.

The first two criticisms can be dealt with quickly. If either the cladistic method is fundamentally flawed – that is, it cannot reconstruct the branching pattern of the tree of life – or the data we use are flawed in some way, then we would expect that running the same analysis on two or more different and independent data sets would give different and contradictory results.

In fact, we found the opposite. Mast analysed several independent genes, and I analysed morphological and anatomical characters. All analyses pointed to the same answer (at least in broad outline). The fact that we got more or less the same answer from independent data sets gives us confidence that the analysis, both in terms of data and method, is giving an answer that must mean *something*. It can't be discounted easily as simply nonsense or an error.

Interestingly, this is an important difference between modern taxonomy based on cladistics and the old intuitive taxonomy – when we use cladistics we can rigorously test our answers. No such test is possible using the old ways.

The third criticism – that despite our new knowledge of the relationships in *Banksia-Dryandra* we should maintain the *status quo* – is also, I believe, hard to argue. As explained above, this would result in two genera that are quite different in kind, and would result in the anomalous situation of some *Banksia* species being more closely related to *Dryandra* species than they are to other *Banksia* species, something that Plato himself would object to. I also believe that if we were to keep the two genera, then generations of newcomers would make the old mistake of thinking that they are related in the way of Figure 1, which is false.

Such mistaken thinking may then hold back future interesting research. For example, the difference in distribution of banksias and dryandras can be very neatly explained now that we understand their true relationships. Dryandras are restricted to south-west Western Australia, while banksias occur more widely around southern, eastern and northern Australia and into the islands to our north. Our new understanding helps explain this – the dryandra branch evolved from its *Banksia* ancestor relatively recently, after the drying of the continent isolated the south-west from the remainder, and they never escaped from this south-west origin.

Similarly, realizing that dryandras are specialized members of *Banksia* raises the interesting question: what happened when the first dryandra evolved from its *Banksia* ancestor, and why? Dryandras are highly successful – there are more species in the dryandra branch than in the rest of *Banksia*, and the dryandras appear to have colonized different habitats. Wondering how they did this makes the group more fascinating even than it was before.

Science for science's sake?

A common charge against taxonomists who make controversial name changes is that it's either 'science for science's sake' or done without consideration of the real world.

I believe that both these charges are false. Modern taxonomy *is* a science (the old taxonomy arguably was more an art, as its results were not testable). Like any science, taxonomic knowledge evolves. If our knowledge changes and the change can be debated and tested and found to be correct, then I believe we should accept it even if it's discomforting. The idea of any science sticking with a *status quo* just because it's comfortable and familiar is deeply troubling.

Instead, I urge the readers of this Newsletter to take onboard the new thinking. Dryandras are special banksias – and I think this makes them even more fascinating than they were before.

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[1] This criticism is particularly common when molecular data are used. The argument goes like this: the gene sequences used in molecular analyses amount to a tiny fraction of the total set of genes in a plant, so how can we possibly get any meaningful answer from such a tiny sample?

Grafting update

In August/September I continued my grafting exploits, putting down just on 300 grafts covering 31 different banksia species and 20 different dryandra species. At this stage (early January 2008), I have 29 'successful' banksia species from these grafts and 17 'successful' dryandra species. A key reason for such pleasing results is that I seem to have solved the problem of dieback of the stock at the graft union by leaving a leaf at the tip of the sliced stock. Dieback of the stock to the first leaf had previously resulted in 80-90% failure rates, whereas I have not had one case of dieback with this batch. Addressing the dieback problem has really given me a chance to see which species can and can't be grafted.

All my grafts use one of the three Banksia integrifolia subspecies – integrifolia, monticola or compar as rootstocks. At this stage, I haven't formed an opinion on which of the three is superior. Seed is more readily available for the integrifolia subspecies, so I intend to concentrate more on this subspecies unless one of the others quickly shows superior results. I intend to trial *B. cunninghamii* and *B. penicillata* next spring to assess their potential as rootstocks.

The table below provides a summary of the results of the August/September dryandra grafts. It's still way too early to make any assessment of the compatibility of each species, but the continuing healthy growth of a number of grafted dryandras and banksias in our garden (some now over two years old) is cause for optimism. Unfortunately the most vigorous of the dryandra grafts is a dryandra I have been unable to identify. I have attached a photo to see if Margaret or Tony can identify the species. Two plants in our garden are super healthy and have grown vigorously since being planted two years ago. Other grafted dryandras growing well in our garden are *D. longifolia subsp. calcicola*, *D. comosa*, *D. fraseri var. ashbyi* (Eurardy form) and *D. foliolata.*

A number of grafted banksias are also growing beautifully in our garden, the most vigorous being *B. brownii*, *B. laevigata subsp. laevigata*, *B. media*, *B. solandri*, *B. speciosa* and *B. lemanniana*. These six species are my easiest banksias to graft and I can achieve over 80% success rates from each of these species.

After a month away on holidays in October, I continued grafting in November and December. Most of these grafts were with banksias. However, one notable new success has been *D. quercifolia* with six successes from seven grafts taken from a very young plant I purchased in October. I had previously been unsuccessful with *D. quercifolia* from a number of attempts from a mature plant.

The following table provides a summary of the results of my August/September grafts to the beginning of January. I'll provide a further update in autumn on how the grafts progress through summer, and on the outcome of my November/December 2007 grafts.

August/September 2007 Grafting Results

Species	Success rate as at 16 January 2008	Comments
D. baxteri	1/1	In early stages but growing strongly.
D. brownii	1/1	Looking great – growing quickly.
D. comosa	3/3	Looks very compatible - have one in garden 2 years old growing well.
D. formosa	0/12	Proving to be the most difficult dryandra at this stage. A couple of November grafts are looking promising.
D. fraseri var. ashbyi (Eurardy form)	4/5	Four survivors growing well.
D. fraseri var. fraseri	2/4	Both successes growing very quickly.
D. glauca	0/6	All grafts were off mature plant and failed to take.
D. hirsuta	5/8	Successes look healthy though growth is slow.

D. insulanemorecincta?	2/2	Both growing vigorously.
D. longifolia subsp. longifolia	1/2	Success looking very healthy.
D. longifolia subsp. calcicola	2/2	Looks very compatible - have one 12 months old in garden growing well.
D. nobilis subsp. fragrans	4/7	All took but three have subsequently died which is a concern.
D. nobilis subsp. nobilis	6/7	Successes growing vigorously.
D. platycarpa	0/1	Initially took but died due to stock dying – need more trials.
D. praemorsa subsp. praemorsa	2/2	Both looking healthy.
D. praemorsa subsp. splendens	12/21	Most initially took but some subsequently died. Survivors look good.
D. ??? (see photo)	3/3	My easiest dryandra to graft – can expect close to 100% success. Have two plants 2 years old in garden growing vigorously.
D. squarrosa subsp. squarrosa	4/4	All looking good. Scion off mature plant.
D. subpinnatifida var. imberbis	0/3	No success so far but intend to do more trials off one plant in a pot.
D. tenuifolia subsp. reptans	2/3	Pleasing given that previous attempts had failed.
D. tenuifolia subsp. tenuifolia	2/2	Previous successes had died after six months, so jury is still out.

Phil Trickett
AINSLIE ACT

Dryandras in our Canberra garden

We have been growing dryandras in Canberra since we remodelled our garden in 2001-02. We find the frost doesn't seem to worry them too much, although we are probably protected from the worst frost as we are located on the bottom slopes of Mt Ainslie. Dryandra leaves must be amongst the toughest as our dryandras were also unaffected by a severe hailstorm which ripped through the centre of Canberra in March 2007 and left its mark on almost all our plants.

Our biggest problem has been the drought which has been severe here in Canberra since 2001. Our garden is exclusively native and we have found that most of our plants fail to thrive without watering in these testing drought conditions, although in general they manage to stay alive. About a year ago, we decided that a dripper system could not be put off any longer, and just a small amount of watering during the very worst of the hot and dry periods has made a very noticeable difference to all of our plants, including the dryandras.

We are now enjoying watching our dryandras survive and begin to flourish. We had good rain in December and January is proving to be the usual hot summer. The dryandras which are doing extremely well in the garden after early periods of struggle include *D. polycephala*, *D. lindleyana subsp. lindleyana var. lindleyana*, *D. nivea*, *D. porrecta*, *D. plumosa subsp. plumosa*, *D. nervosa*, two plants of *D. corvijuga*, *D. mucronulata subsp. mucronulata*, *D. fraseri var. fraseri*, *D. drummondii var. hiemalis*, and *D. brownii*.

Of these, only *D. polycephala*, *D. porrecta*, *D. plumosa subsp. plumosa*, and *D. drummondii var. hiemalis* have flowered. *D. nervosa* has some lovely buds forming. Some of these plants were grown from seed from Margaret and other sources but others were bought in pots. One of the most spectacular was *D. drummondii var. hiemalis* last winter (see photo). Its foliage continues to be a garden highlight.

Other dryandras now starting to show signs of healthy growth include *D. speciosa*, *D. comosa* and *D. hirsuta*. Some of Phil's grafting experiments are also going well in the garden beds, including *D. longifolia subsp. calcicola*, *D. foliolata*, and another one we're still trying to identify. In addition, we have quite a few young plants of other dryandra species in the ground and others ready to go in when we can find the space, so we hope to be able to report on their progress at a later date.

Catriona Bate
Ainslie ACT

Proposed Name Changes

Having read Kevin Thiele's article in response to Tony's request for an explanation of the need to change *Dryandra* to *Banksia,* I found it very interesting but not a justification for name changes as far as I can understand it.

The new scientific discovery about the evolution of *Dryandra* from *Banksia* is obviously a breakthrough and no doubt many more will be made for other genera. I believe *Grevillea* and *Hakea* are being researched as well as several other genera.

Where will it end? Does the elapsed time since the split influence the decision to merge a genus with its ancestral genus? I understand that there are 'throwbacks'- some dryandras are more closely related to some banksias than they are to other dryandras but this surely occurs in many, if not most other genera. Taken to the extreme, all grasses would indeed end up as *Poa* or whatever the ancestral grass was.

Where does *Protea* fit? Did it too evolve from *Banksia* ? I believe that it has been found that Plane Trees, in a different family altogether are closely related to *Banksia.* Will the new rules of taxonomy have to take this into account?

I think that it was Robyn Williams who said that botany is not a science but an opinion. The natural world is not helpful, either. It throws up enough problems within a genus, such as intermediate forms. How do you know where to draw the line where a species such as *Dryandra tenuifolia* has intermediate stages between var. *tenuifolia* and *var. reptans* ? (Alex George has chosen to include the intermediate, 'cascading' form in var. *reptans.*)

Recently the scientific world was rocked by the news that Pluto is no longer to be classified as a planet – it is still called Pluto, however!

I wish that research into DNA would be put to work in order to save some of our plants from extinction. There is an urgent need to establish the number of plants of *Dryandra aurantia, D.* Boyup Brook and *D. ionthocarpa* subsp. *chrysophoenix* left in the wild, so as to put recovery plans into action. I believe there are only a very few. Because of their underground stems they are impossible to count. What looks like a population may only be one or two plants. They set either very few seeds or non-viable ones. Unless I'm mistaken, a DNA analysis of the leaves would be the only way to solve this problem.

Margaret Pieroni 14/1/08

Further thoughts on the new taxonomy and the incorporation of *Dryandra* into *Banksia*

Kevin Thiele's article goes a long way to showing us why plant names are not "fixed" but will continue to change as new technologies are developed and our understanding of relationships between individual species or groups of species, or between genera or families continues to increase. Kevin finished with a plea for us to think of dryandras as "special banksias", a feature which makes then even more fascinating than before. I am not yet prepared to go that far, especially as I do not understand the science which underlies the proposal, and from my reading I find that there are still a number of respected scientists and taxonomists who question at least some of the more extreme aspects of the new taxonomy, such as the proposed PhyloCode, touted by some as a "better" system of classification than the Linnaean system which has served us for over 200 years! You may well ask where it will all end!!

For those with a burning desire to know more, I have included a few of the papers I have looked at over the last few months and I am sure that there is much more discussion on the Web. The online encyclopedia *Wikipedia* is also a good source of information on just about any topic you care to research but be warned, many of the articles are pretty solidly scientific and not all that easy to understand. As might be expected, there are essentially two camps. Those with more traditional views regard cladistics and the molecular technologies as just a passing fad, one of a long line of "bandwagon" research techniques which were/are claimed to solve all taxonomic problems (see for example Kruckeberg 1997). Then there are those scientists (probably the majority these days) who view the new techniques as being important new tools in helping sort out classification problems and providing a more robust scientific basis for taxonomic decisions. It is obviously popular – Weakley estimated in 2005 that 9 out of every 10 papers published in taxonomy were molecular based (Weakley 2005). While it was true that a considerable number of these papers only resulted in changes at the family level and above, ie they had relatively little affect on species names, increasingly, "systematists are intensively sampling a genus, or group of genera, and drawing conclusions that often result in changes in generic circumscriptions – lumping genera or discovering that subgenus X is more closely related to genus Y than to the remainder of the genus and must either be segregated as its own genus or lumped into genus Y" (Weakley 2005, p.56). This is of course what has happened to *Dryandra* and undoubtedly will occur in many others.

Yet even within the "pro" technology camp, there are disagreements. Some scientists are happy to accept paraphyletic[1] taxa in a classification scheme while others insist that a classification scheme should reflect strict monophyletic[2] phylogenies[3] (Barrett et al 2005), (see for example Brummitt 2003). This leads to esoteric arguments which are way beyond my interest or understanding but they again demonstrate that there is no one or simple answer to problems. Probably the most extreme example of disagreement is PhyloCode, essentially a proposal to completely overturn the old (Linnaean) classification and replace it with a new system which its proponents claim is more in line with the current understanding of evolution. Instead of the traditional ranks such as species, genus, family, order etc, PhyloCode assemblies organisms (plant, animal etc) into "clades", defined as "any set of organisms with a common ancestor. – each clade's name would refer to a node in the tree of life—" (Pennisi 2001). As far as I know, the whole concept is still very much a concept and I don't believe that it has made any headway in Australia, one of its main difficulties being that there is no agreement on how to name "old" species in the new system (see Pennisi 2001, also Brummitt 1997 and there are probably a host of for and against papers on the Web).

Returning to the situation with *Dryandra* and *Banksia*, I was very interested in the preface discussion in the special issue of *Australian Systematic Botany* on "Generic concepts and modern taxonomy" (**18**(1), 2005) (Barrett et al 2005). The whole issue was devoted to papers discussing the fluid situation in the current taxonomy of several of the larger Australian genera and presenting the various authors' attempts to find stable classification schemes for these groups, eg the *Pultenaea* group, Mirbeliae, the large and cosmopolitan Hibisceae, saltbushes, as well as mosses, algae etc. Also included was Austin Mast's third paper on the *Banksia/Dryandra* relationship (Mast et al 2005). The preface authors noted that some papers advocated substantial changes to the current understanding of the taxonomy of groups and recommended a cautious approach to implementing these changes because of Australia-wide and international ramifications. They saw it as preferable that there be more input from the botanical community and collection of more data to ensure that a consensus is reached on the most suitable classification. They also considered that it was important for the end-users of classification schemes that the "*status quo*" be maintained until there was sufficient data to be confident that the final classification was as stable as was possible with current knowledge.

With this last point in mind, I will quote their comments on *Banksia/Dryandra* which they mentioned specifically. "In the case of *Banksia/Dryandra,* it is easy to recognise the two "genera" on morphological grounds and many will prefer to do so, even though this renders *Banksia* paraphyletic[1]. The classification as two genera is considered by some to be more practical, even if it does not reflect true genetic relationships in the group concerned." (Barrett et al 2005, p.i). It is a pity that there has not been more discussion among professionals about this and other proposed changes eg is the small number of species examined by Mast truly adequate to support fully the contention that ALL dryandras be sunk into *Banksia*? And there is still the question as to whether the "new taxonomy", for all its power, can help with the separation of varieties and subspecies (as defined by classical methods) from species, or as Margaret has suggested, can it have practical field application in the important business of distinguishing individual plants in a population of suckering plants.

Tony Cavanagh

Definitions

1 Paraphyletic A paraphyletic group is one that excludes some of the descendents of the common ancestor that gave rise to them. Thus in the Mast/Thiele proposal, *Dryandra* and *Banksia* both arose from a common ancestor so that if *Dryandra* is maintained as a separate genus, then *Banksia* becomes paraphyletic because it does not contain the *Dryandra* group.

2 Monophyletic A monophyletic group contains all the taxa derived from a common ancestor, and only those taxa; in our case, it must contain both *Banksia* and *Dryandra* but nothing else.

3 Phylogeny/ies Most simply defined as the evolutionary relationship of organisms, usually depicted as a branching tree diagram (phylogenetic tree or cladogram).

(For an excellent and well illustrated introduction to Evolutionary Biology, see Knox et al (2001), p.788-

References and additional articles.

Anon. (2007). "Biology's big bang". *Economist* **381**(8542) of 16 /6/2007, p. 13. (Discusses the role of RNA in molecular research, claiming that with increasing understanding of the part that RNA plays in regulating what goes on in the cell, "molecular biologists have gone from thinking that they know roughly what is going on in their subject to suddenly realising that they have barely a clue).

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Brummitt, R.K. (1997). "The BioCode is unnecessary and unwanted". *Systematic Botany* **22**(1), 182-

Brummitt, R.K. (2003). "Further dogged defence of paraphyletic taxa". *Taxon* **52,** 803-804.

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Kruckeberg, A.R. (1997). "Essay: whither taxonomic botany in the 21st century". *Systematic Botany* **22**(1), 181-182.

Mast, A.R. (2005). "An assessment of old and new DNA sequence evidence for the paraphyly of *Banksia* with respect to *Dryandra* (Proteaceae)". *Australian Systematic Botany* **18**(1), 75-81.

Meiri, Shai and Mace, Georgina M. (2007). "New axonomy and the origin of species". *PLOS Biology* **5**(7), 1385-1386. (Argues that there is a tendency for "taxonomic inflation" in describing excessive numbers of new species and that taxonomists should present sufficient morphological behavioural and genetic differences to warrant the separation).

Pennisi, Elizabeth (2001). "Linnaeus's last stand?". *Science* **291**(5512), 2304- (General discussion on PhyloCode).

Weakley, Alan S. (2005). "Why are plant names changing so much?" *Native Plants* **6**(1), 53-58.