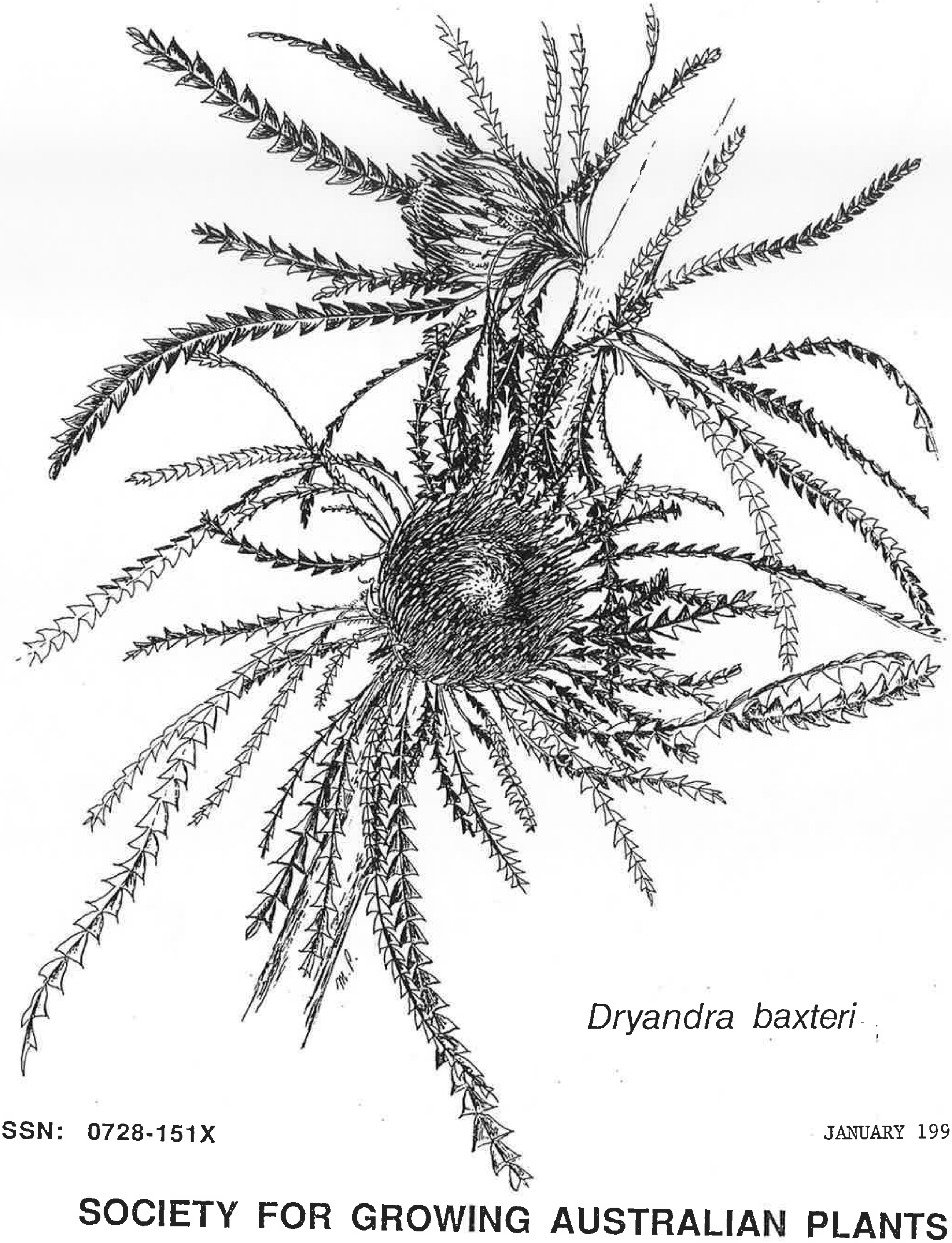
DRYANDRA STUDY GROUP

NEWSLETTER NO. 21



Dryandra baxteri

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SOCIETY FOR GROWING AUSTRALIAN PLANTS

DRYANDRA STUDY GROUP

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Welcome to another year and, I trust, a year of successful dryandra growing. I have used only some of the articles I have available for this Newsletter (many thanks to all contributors- it makes the editor's job much easier!) because I wanted to ensure that I could use all of Keith's excellent article on germination. I have had some very good reports on it and I'm sure that part 2, particularly his discussion on such factors as the influence of age and storage of seed on subsequent germination, the species which shed seed readily versus those that retain seed, and speed of emergence and susequent survival, will be of much interest.

Late 1991 was a busy year for the Group. There was the week-end get-together at Shapparton in August for eastern members followed a few weeks later by the tour of dryandra areas in Western Australia led by Margaret. I have reported on the former in this Newsletter and Alf Salkin is doing an article on the latter for the next Newsletter. Margaret also prepared a Dryandra Exhibition in October for the Western Australian Wildflower Festival held at Kings Park in September-October. This dovetailed in with the International Protea Association Congress and the A.S.G.A.P. Conference and attracted a lot of interest from local and overseas visitors. The display featured a nice collection of fresh dryandras as well as some of Margaret's beautiful photographs and drawings of dryandras.

Margaret has provided another detailed article about her dryandra hunting and I would welcome similar articles, long or short, from other members reporting on their trips or, as Val Crowley's article does, describes possible new or interesting dryandra areas. David Randall's "egg box" method is certainly worth trying and although (because I'm not well enough organised) it hasn't been especially successful for me, I would like comments from other members.

During last year, Margaret joined the Group up with the Australian Network for Plant Conservation. The Network has a number of aims but is mainly concerned with establishing a multisite National Endangered Species collection to form a base for recovery programmes and with co-ordinating research and providing information to interested organisations. I believe this is a very worthy cause, particularly as there are several endangered dryandras, and I will endeavour to keep members informed through this Newsletter.

I am looking to organise another get-together in July-September this year. If anyone has suggestions, could you please contact me. In the meantime, enjoy the Newsletter and happy dryandra growing.

Tony

Tony Cavanagh

DRYANDRA FIELD TRIP AUGUST 1991

After weeks of lashing rain and gale-force winds which wreaked havoc among the small trees and tall shrubs in my garden, it was with some trepedation that Shirley Loney and I planned a field trip for the 6th August with the aim of exploring back roads south of Moorine Rock and down to Ravensthorpe. As it turned out, the weather improved on that day and we had perfect conditions for our three-day trip.

When Keith Alcock first visited me in September '84 he marked on my road map of the South West a stretch of road as being "good for dryandras". I have worn out two maps since then but I carefully marked in the location on each new map.

In the intervening years we have learned that the particular species that Keith wanted me to see, his "pteridifolia" form no. 4, has been described and named *D. shanklandiorum* (see newsletter no. 15).

Though I have travelled quite extensively throughout the South West and I have visited the Cadoux location of *D. shanklandiorum*, somehow I never quite managed to get to that stretch of road south of Mt. Hampton. So that became objective no. 1. The other main object of the trip was to photograph Keith Bradby's hybrid in flower in the Ravensthorpe Range (newsletter no. 15).

A little further south than Keith had indicated we came across the population of *D. shanklandorium* growing in gravel among other low shrubs and mallee eucalypts, *E. burracoppinensis*. The only other dryandra we found there was *D. conferta* which is common in the general area. The plants of *D. shanklandorium* were smaller than those at Cadoux - about half the size, the biggest being about 1m x 1m, but the flowers were no less huge. The tangled, pinnate leaves are a marvellous soft blue-green. Most of the flowers had the lovely rich rust-red or copper-coloured limb but lacked the pink flush on the perianth of some of the Cadoux plants. Some of the flowerheads would have been 12 cms in diameter when fully open. I didn't observe any flowers with the silvery - grey limb like the plant in my garden has. They really are magnificiant, except for their foul odour.

After some photgraphy we drove on, trying to expel a blowfly that had deserted the dryandras to join us. It must have known something because 30 or 40 kms further south, by a very indirect route we came across another population of *D. shanklandiorum*. This time they were growing in deep yellow sand among taller *Eucalyptus burracoppineusis* and again with *D. conferta*. The plants were much larger in this population. Most of the flowers were finished but all of those I did see had grey limbs and the plants resembled much more the one in my garden.

Question: Is this the source of the seed we bought years ago as *D. preissii* ? Or, does *D.shanklandorium* produce the more colourful flowers in laterite grael and not in sand ? Has anyone grown plants from our seed bank which have produced flowers with a rust-red or copper limb ? I would be interested to know. It will be a few years before my newly-germinated batch of seeds from one of the "colourful" populations produces flowers.

We approached Hyden down the Humps Road and came across an area of low heath with many proteacae and other genera typical of the kind of vegetation that occurs just north and to the south of Newdegate. Dryandras here include the prostrate *aff. ferruginea* (no. 34), the tall column-like *aff. armata* with its pale lemon flowers similar to *D. cirsiodes* and *D. conferta*.

A prominent small tree in this type of habitant is the compass bush, *Allocasuarina pinaster*, which looks like a conifer and always leans towards the south.

The following day we set off on, for us, unexplored back roads that skirt the huge Dragon Rocks Nature Reserve, north of Newdegate. At it's northern edge we found, in flower, *D. ferruginea* (typical), D. no 13 and the winter-flowering *aff. drummondii*. Further south we again came to the type of habitat that I mentioned as also occuring north of Hyden. South east of Newdegate *D. pteridifolia* also occurs with the usual dryandras of this vegetation type, the *D. ferruginea* type being once again the prostrate one.

On to the Ravensthorpe Range and the long-hoped-for flowering hybrid. When we came abreast of the plant I saw at once an inflorescence low on the bush, standing out in all it's glory in the full sun. It really combines the most attractive features of it's (supposed) parents, *D. querifolia* and the *aff. ferruginea*, having the showy bracts of the latter though not so long, but still longer than the flowers themselves. The colour of the bracts, rather than rust-red, are golden yellow with dark brown tips.

Surrounding the hybrid plant were tall shrubs of *D. querifolia*, mostly still in flower, some, incidently with pink flowers. The other parent, the *aff. ferruginea* had flowers still in bud. The other, taller, hybrid plant did not have any open flowers but I was not disappointed because, from the look of the spent flower - heads it more closely resembled *D. querifolia* with it's smaller bracts. I expected the first plant to have a more spectacular flower and certainly was not disappointed with it!

As we had made good time, not having had to wait for long periods for the sun for photography, we decided to push on to the Stirling Ranges where I wanted to photograph the plants of the *D. aff. armata* at Mt. Iris while there was still enough light. This species was in full flower and some, instead of all yellow, are a deep pink similar to the pink form of *D. querifolia*. Also in flower nearby was *D. brownii*.

On the way home I wanted to check the exact location of a plant of the prostrate *D. tenuifolia* form at Gnowangerup. It is enormous, covering about 4 x 5 m with clusters of flowers around the edge. This is the ultimate in groundcovers and appears to be fairly easy to grow, once established in the garden.

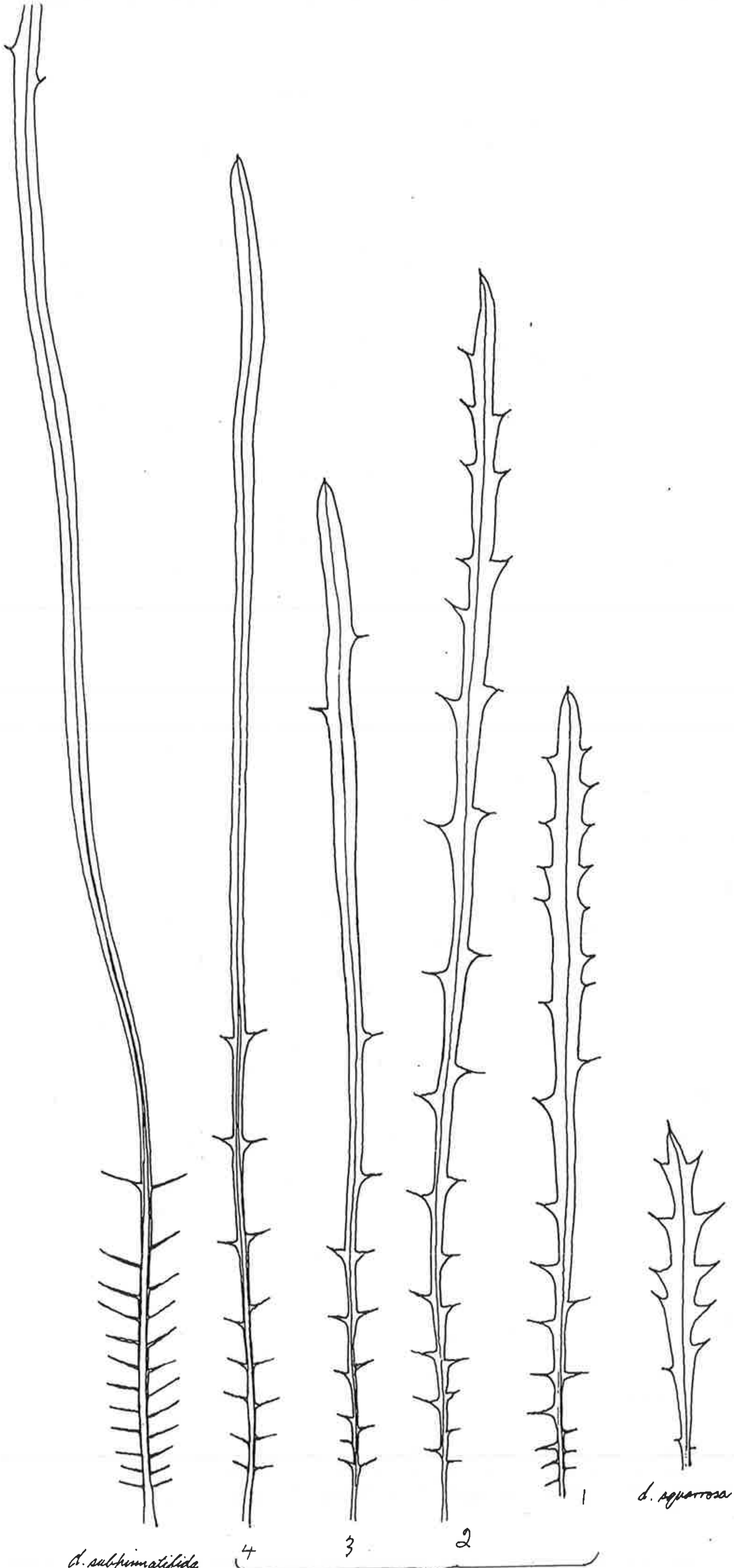
Approaching Nyabing we noticed a dryandra which turned out to be sp. J (no.45), though a more upright-growing, densely-foliaged form than those I'd seen previously. As usual the she-oak, *Allocasuarina huegeliana*, which is usually associated with this dryandra was not far away, probably indicating granite not far below the surface of the sandy soil.

North of Nyabing, at a favourite dryandra spot, in deep gravel there were six dryandras, four in flower, *D. ferruginea, D. aff.seneciifolia* (no. 5), no. 13 and the robust, upright *aff. armata* no 8.

At our last stop, between Lake Grace and Dumbleyung we saw, *D. vestita, D. aff. nervosa* (no 39), *D. ferruginea*, D. no. 8, D. no. 13 and what I determined from the shape and size of the seed follicle, to be D. no. 6, an *aff. conferta* that Keith Alcock found several years ago east of Dudinin. This also occurs at Corrigin and I think I collected a specimem of this one south of Dumbleyung in 1985 but when I returned hoping to find it in flower, the plants had been "bull-dozed".

Once again we had a very enjoyable and productive trip with a few dryandra surprises thrown in. I'm looking forward to showing some of our members some of my favourite places in October on our Stirling Range trip.

Margaret Pieroni.



d. subpinnatifida 4 3 2 1 d. squarrosa

Val Crowley's hybrids

A *DRYANDRA SUBPINNATIFIDA* HYBRID?

On the 12th August '91 my friend Jan Smith and I were carrying out a Road Verge Conservation Value Survey in the West Aurther Shire, and were in the Boolading area South West of Darken when we observed some "different" Dryandras flowering. We promptly investigated and found them to be different to anything we had previously seen in our district.

The plants were very attractive, mainly mound formed, approximately up to 1.2 - 1.5 meters high, and they were flowering in profusion, and were scattered over an area of approximately 2 acres of what was an old gravel pit/rubbish dump.

We wandered happily around for quite some considerable time (no wonder the Road Verge Survey is still incomplete), then suddenly we remembered we had climbed through a fence on the roadside and we were on private property, which made us feel a little unsettled.

I picked a specimen to take home to try and identify, and in passing picked three others. I tried to key them out that evening and thought perhaps the finest leafed one may have been *D. subpinnatifida* - then became somewhat confused with the specimens thinking perhaps the coarsest leafed might be *D. squarrosa*, so decided to send them to Margaret. (See attached leaf drawings).

Margaret believes we have found a hyrid "swarm" of crosses between *D. squarrosa*, which grows among the plants, and *D. subpinnatifida*, and upon a further visit to the area on 26th August found a specimen that could be *D. subpinnatifida*.

The hybrids mainly seem to have the mound form of *D. subpinnatifida* with the flower shape of *D, squarrosa*, with the leaves many and varied. They either have a shorter flowering time than *D. squarrosa*, or perhaps we found them near the end of their flowering. They were a mass of flowers on 12th August, and nearly finished on the 26th. We visited the area again on the 8th October and only managed to find two or three very small flowers. *D. squarrosa* was still flowering well.
Unfortunately the landowners now have sheep grazing in the paddock and they, or something else, have been eating the tips of the plants and breaking pieces off. It is hoped the sheep will soon be moved.

Val Crowley

THE TRIALS AND TRIBULATIONS OF A PLANT TOUR LEADER

(Editor's note- I have extracted the following notes from a couple of letters I received from Margaret. They show some of the frustrations we all can experience due to the thoughtless of others with indiscriminate clearing and burning, although of course in a couple of cases, mother nature also takes a hand).

After the ASGAP Conference in Perth this year, I was part of the "crew" on the southern post-conference tour with Marion Backwell and Kevin Coate. We had more than 40 people in one huge coach so it was quite a job to identify all the plants they wanted names for. We covered a lot of territory and saw many dryandras including most of the un-named ones and the hybrids at Mt. Desmond. Not many species were in flower and when only one good plant of no. 36 was found with flowers, I promised the photographers bigger and better ones at Mt. Short. Imagine how angry I was to discover that the plants there had been buried under the dirt and gravel from the old gravel pit. I couldn't find even one plant there. At Kendenup, my favourite location for no. 3 had been burned since January and there were only weeds in their place. To top it all off, the lovely little stretch of road verge nine kms. east of Wandening where the best aff. drummondii (no. 38?) grow had been scraped for road widening! It was to have been the last stop on our dryandra weekend.

Margaret Pieroni.

THE EGG BOX METHOD OF GERMINATING DRYANDRAS

Over the years, there have been many descriptions of methods of germinating dryandra seeds. One technique which appears to have been little used is the egg box or egg carton method which I have found particularly successful for a wide range of seeds, including dryandras as well as some of the very difficult-to-germinate genera such as boronia and pimelia. My procedure is as follows:

To ensure that seeds are not mixed up, I number the bottoms of the egg carton cavities with a texta pen and write the names of the species on a small piece of card which is kept with the cartons. Remove the tops from two egg cartons and soak them in a bucket of warm water containing disinfectant. I leave them for only 4-5 minutes although other people have used longer (I find that with too long a soaking, the cartons become too wet). Also lightly sterilise a plastic bread bag. Soak the seeds in warm water for 8-12 hours in plastic cups or similar and then tip the seeds and water through a strainer. Transfer the seeds to the cavities of one of the egg boxes and put the second carton on top so that it fits snugly. Seal up in the bread bag and place in a warm spot (I use the second shelf in my hot house, out of direct sunlight). Check every three or four days, adding few drops of water if the carton is drying out but don't get it too wet or the seeds will go mouldy.

When seeds shoot, I pot them into 3" tubes. I use a square ice cream container with a couple of inches of coarse sand in the bottom and enough water to keep the sand wet. This holds 15-16 3" tubes on top of the sand.

In the tubes, I use a red sandy loam which I have also used in my raised beds. I use it in preference to soil-less potting mixes because I think plants do better when planted out in the garden.

Because of lack of room in my hothouse, I pot up into 6" pots when the roots come out of the bottom of the 3" tubes. Somewhat surprisingly, this can occur even before the seedlings develop their first true leaves! The 6" pots are kept in a warm, sheltered spot.

I find May-August the best time for this method of propagating plants.

Sometimes I grow a plant on in a large pot for a year before planting out if I havee had trouble establishing a species.

David Randall

(Editors comments: Many of the group might not realise that David Shiells, one of our members pioneered the use of the egg box method. He first described it in the September, 1974 issue of *Australian Plants* as a simple means of propagation for many of the larger-seeded species, especially acacias. It is interesting to note that David (Randall) also finds it satisfactory for some of the very small seeds.

I have used the egg box method on a number of occasions, with mixed success I'm afraid. The major problems I have always found are the development of moulds on some of the seeds after a few weeks and drying out of seeds, sometimes after they have germinated, if I don't keep a close eye on them and remove them for potting. I don't tend to be very organised with my seed propagation, hence I seem to have better results when I sow them in a normal propagating mix or a sand/peat moss mix. Here, as long as I keep the pots watered, it doesn't matter if I'm a bit slow in pricking seedlings out. Absolute cleanliness is imperative if you are to minimise fungal infection and whenever I am checking seeds and/or removing them for potting, I frequently dip the tweezers I use in a Dettol or White King solution. I would be interested in other members' experiences with the egg box method.)

IS MOLYBDENUM ONE OF THE ANSWERS TO YELLOWING IN DRYANDRAS?

I wish to acknowledge a helpful hint from Ron Fowles of Blewitt Springs on growing banksias and dryandras. He has had considerable success with a lot of WA species. Ron had in turn taken this tip from another source, which means that he is not only ready to pass on any useful information, but that someone else has indeed had success with the same formula. Molybdenum is a trace element that seems to be lacking (at least in the soils of Kuipto and Blewitt Springs) or is not present in sufficient quantities for some varieties of banksias and dryandras. This is evident by severe yellowing of the leaves, in some cases in the old, in other cases in the younger leaves. But Ron and I tried more obvious remedies such as total trace elements and iron chelates without the success of molybdenum. It is not readily available from nurserymen but is currently stocked by Phillip Smult of Growers Supplies at Burma Road Pooraka, phone (08) 3496560.

Gary Goland, Meadows.

(Editors note: This article first appeared in the South Australian *S.G.A.P. Journal* of May, 1991 and was supplied to me by Margaret. It may contain the answer to occasional problems which arise when iron chelates don't seem to be able to correct yellowing in proteaceae. Again, I'd be very interested in any observations or experiences of members with the use of molybdenum or other materials for treating yellowing in dryandras.)

THE SHEPPARTON GET-TOGETHER, 24-25 AUGUST, 1991

The Shepparton Week-End grew out of a similar get-together at Cranbourne in 1990 when Margaret was visiting Victoria. David and Pam Shiells were our hosts and did a marvellous job with lunches, morning teas and of course organising garden visits. We had 19 Victorian and New South Wales members and friends for the two days but this was swelled to over 30 on the Sunday when we were joined by a number of Shepparton and Wangaratta S.G.A.P. members many of whom were lured by the prospect of seeing David Shiell's "block" which he planted over 15 years ago and which hadn't been visited by a group in years.

The first point of call was David and Pam's garden. David has established a wholesale nursery but also has a great garden where many of the rarest grevilleas reside and apparently do very well. We spent about three hours walking around admiring the wide range of their plants and many had to be dragged away for lunch! The soil is terrible - heavy, shallow clay, often very wet - so David has experimented with raised beds using a variety of materials including coarse gravels. As he is several kilometers out of town, he has a septic system with a special "evaporation bed" of sand above ground to absorb the effluent. It makes a wonderful growing situation for kangaroo paws! Because of limited space and his many interests, David didn't have any of the larger dryandras but was growing some of the smaller ones, including, I think, nearly every form of *D. ferruginea* that Keith had. They looked great, all were healthy and several had either flowered or were flowering. However, his pride and joy at the time of our visit was the rare species "John Cullen" in flower. From my own experiences with *D. ferruginea* and its various forms and from what I saw at Davids, I would say that many of the ferruginea forms are very hardy, as well as having spectacular flowers. Perhaps one of the most puzzling things is why they are so often difficult to raise as seedlings. They need a very well drained mix and even with this provided, I have still had high losses.

After a bar-b-que lunch, the afternoon visit was to Laurie Baglin's garden and nursery. Laurie has 5 or more acres and has a particular interest in hakeas of which he had some of the rare and newly named species. He also had a nice stand of W.A. banksias and a number of dryandras. Some of his plants were over 15 years old. Areas of the garden were now heavily shaded but his dryandras were still hanging on.

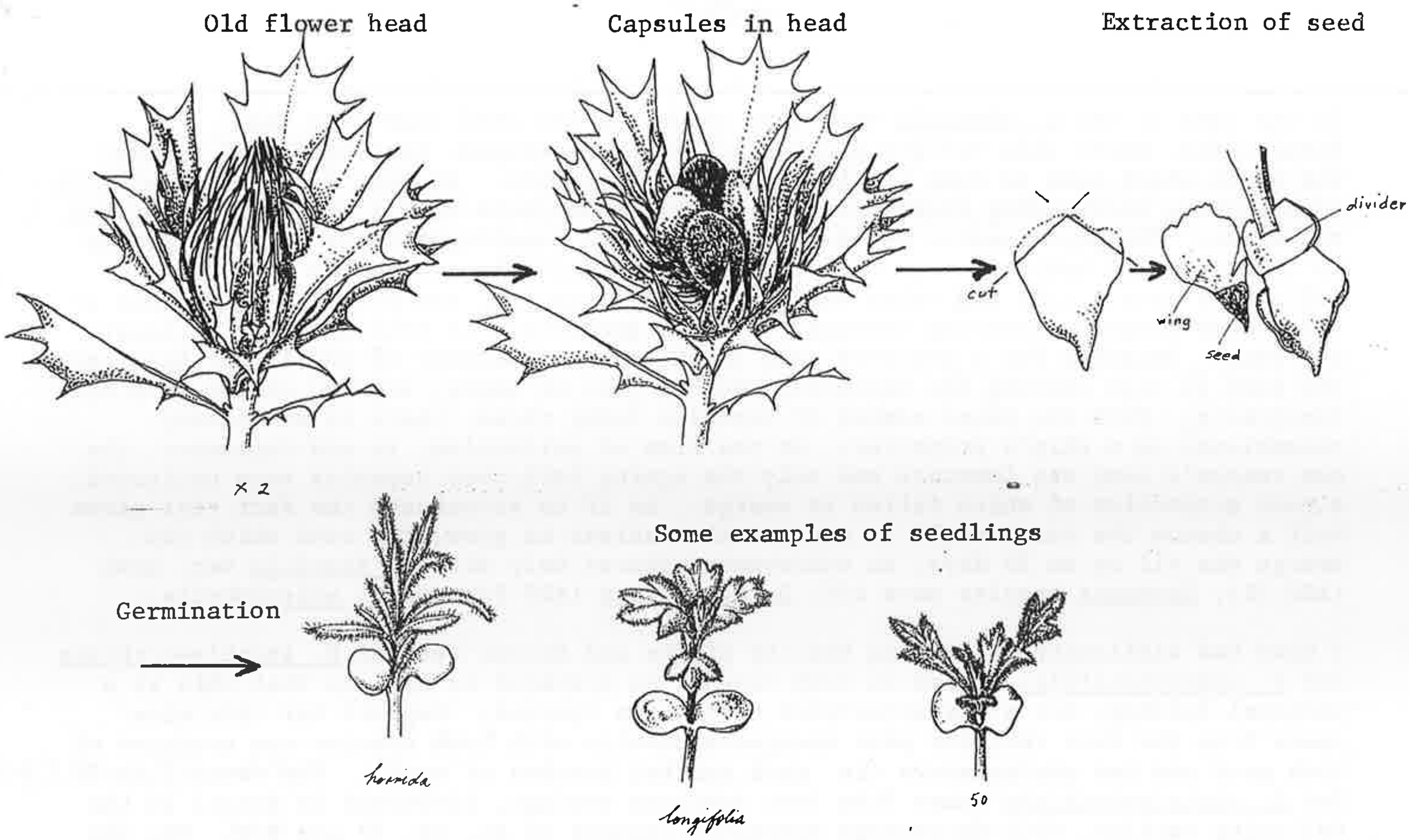
We had a counter-tea at a local pub and then adjourned back to David and Pam's for slides, a display of dryandras and a general chit-chat. I managed to collect around 30 species from the garden, many in flower, and Ray Purches and David brought a few more. I used the slides I have for talks and Hartley Tobin also had another dozen very nice slides. Both the specimens and the slides created a lot of interest as many of the audience had only seen a few dryandras in flower and most had not visited the west. After the slides, there was a general discussion on propagation and, in particular, what size should my dryandras be for planting in the ground? When I commented that our experince in southern Victoria suggested that dryandras could be put in when quite small, all the people who live in northern Victoria were quite convinced that it is better to wait until plants are large and well-established before putting them in the garden. They claim that their hot, dry summers are too severe on small plants; they have also found that autumn is the best time to put plants in the garden, so we all agreed on that. Can I have comment from members on their experiences with planting large versus small dryandras in the garden?

Sunday saw us visit two gardens and David's "block". First stop was Jan Hall's garden and nursery at Yarrawonga. While Jan doesn't have many dryandras (she told me she has trouble establishing them as it is very hot and dry over summer), she had a very interesting garden with a number of grafted eremophilas seemingly lapping up the conditions. A short drive to Cobram, past a commercial flower farm with a row of perhaps several hundred *Dryandra formosa*s along with banksias and proteas, brought us to David Randall's garden. This was a real eye-opener as it was on not much more than a house block but contained some magnificent and very rare plants. He has about 40 species of dryandra, many quite small but growing well in raised beds, including the un-named species ASG 16 with affinity to *D. mimica* in full flower. Margaret commented later on a specimen that David sent her that the leaves were at least half as long again as anything she had seen in the west! Dryandras certainly seem to like Victoria! (I will report in some more detail on David's dryandras and his growing methods in the next newsletter).

Somewhat dazed after seeing so many plants literally crammed into one small garden, we set out for David's "block". This was several acres of what was originally farm land which David and Pam had planted up some 10-15 years ago with several thousand plants. Prior to our visit, they had not visited the place for several years so the plants had literally received no attention. Hence I was interested to see how dryandras (and other natives) fared when left to their own devices in an area which can be very hot and dry in summer and receive severe frosts in winter. David has "a bit of everything" on the property, with many obscure acacias, eucalypts, grevilleas of course and a good range of dryandras - we all marvelled at his ability to put names to unusual plants that often he hadn't seen for years. While some dryandras had died or disappeared (perhaps eaten by rabbits or sheep), others were quite stunted (eg *D. cuneata* was only 1 metre high after 12 years) but were still alive and had flowered. *Dryandra plumosa* looked about the best, several large plants to about 1.5 m by 2 m, while *D. armata, D. falcata* (a small leaved form), several forms of *D. tenuifolia* and of course a number of *D. ferruginea* forms were also looking healthy. *Dryandra formosa* wasn't happy but *D. nobilis* although quite small, was flowering well. David indicated that from his experience, the dryandras were tougher and hardier than western banksias, a point commented on by Neil Marriot at Stawell.

Unfortunately, all good things come to an end and late on Sunday afternoon, we all reluctantly turned for home. The weekend was enjoyed by everyone and it gave us the opportunity to meet together as a group and talk about dryandras. I am looking for a venue for another get-together this year and while I have some ideas, please let me have your suggestions. David and Pam were marvellous hosts and the smooth running of the week-end was a tribute to their organisation. Thank you, David and Pam, from all of us who attended a great week-end.

Tony Cavanagh



Germination History of a Dryandra

RAISING DRYANDRAS FROM SEED – Part 2

3. DISCUSSION

Both germinability and speed of emergence records showed wide differences between species or species complexes. In almost all cases there was a high degree of concurrence between the two years of data collection, and in most cases within batches of seed of the same or of closely related species. This encourages the view that many of the observations were indicative of real differences and that it is worth exploring the data for underlying causes.

3.1 General Health of Seed and of Parent Plants

It is eminently reasonable to suggest that best results in raising plants from seed will be achieved with sound, well nourished seed from healthy, vigorous parent plants. Unfortunately, there are occasions when the only seed available is from old, drought affected or otherwise unhealthy plants, while depredation by insect pests can further limit the quality of seed that can be found. I am sure that the commercial seed companies have both the time and local knowledge to track down good sources for the Dryandra species that they offer and that, in the main, purchased seed will be of high germinability.

Several of the lowest germination counts I believe I can attribute to the problem of poor seed from unhealthy parents. Dryandra species nova aff. D. serratuloides (ASG 45) and D. sessilis var. nova (ASG 52) are particular examples. Both poor results were from single collections planted in 1987. The seed of the former, which gave only 33% emergence and decidedly slow at that, was from a very hard-pressed population growing amongst grassy weeds alongside cultivated fields just outside of the town of Wickepin. This decumbent population was nearly smothered by the weeds and the seed had been heavily attacked by seed moths, the damage concentrated by lack of other hosts nearby and perhaps accentuated by the cover offered to the egg-laying moths by the surrounding weed growth. Suffice to say that the seed that was available was not that which one would normally choose.

In the case of the D. sessilis var. nova (ASG 52), the seed came from Cape Naturaliste, where this variety grows stark on the headland, bracing itself against the winds which seem to come straight from the Antarctic. At some 2-3 metres tall, it towers above surrounding vegetation, which seldom projects itself more that 50cm into the winds. The poor results at 36.7% emergence are considered to be only partly due to the stressful habitat, more the result of the available seed being past its collect-by date. Like the other varieties of D. sessilis, the plants release most of their seed between flowering seasons, though a proportion is held back for at least one year. Uniquely for a dryandra, ASG 52 sheds the remainder of the flower head once the seed is ripe leaving the capsules, whether full or empty, exposed on the bare old receptacle. With the usual number of capsules being three, there is an uncanny resemblance to a ship's propeller. At the time of collection, in mid-September, the new season's seed was immature and only the ageing left-over capsules were collected, a good proportion of which failed to emerge. As if to accentuate the fact that given half a chance the taxon would be amongst the easiest to grow, the seed which did emerge was all up on 30 days, an achievement shared only with D. sessilis var. nova (ASG 51), Dryandra species nova aff. D. hewardiana (ASG 25) and D. sclerophylla.

I have had difficulty in finding healthy plants and decent seed of D. shuttleworthiana and D. subpinnatifida, though in both cases I am prepared to believe that this is a personal failing, not a characteristic of the two species. Support for this view comes from the fact that the poor emergence results with both species are averages of both good and bad performances (ie. good and bad batches of seed). The overall ~~41.2%~~ 53.5% for D. shuttleworthiana comes from four separate sowings, discussed in detail in the following section, with percentage emergence figures of 24, 50, 57 and 83%. The low D. subpinnatifida average of 48.8% is predominantly due to one result of 18% balancing one of 71% with a 50% figure in between. The message seems to be that the potential is satisfactory if a healthy vigorous parent population can be located. I must confess I find this charitable conclusion a little hard to declare, for I have found both species difficult to grow, partial support for which is shown by D. shuttleworthiana being represented amongst the species showing highest post-emergence losses up to the tubing stage.

No such misgivings are harboured against five other species on the list of underachievers in emergence terms. The D. pteridifolia family, united by their long, deeply cut, coarse leaves are represented in Table 3 by no fewer than four species: Dryandra species nova aff. D. blechnifolia (ASG 22), Dryandra species nova aff. D. drummondii (ASG 38) D. nervosa and Dryandra species nova aff. D. calophylla (ASG 3). Along with the D. nivea family, represented in the same table by Dryandra species nova aff. D. nivea (ASG 29), the two groups are without a doubt in my mind the easiest, most reliable and rewarding dryandras in cultivation, probably the only ones deserving of being called easy-to-grow.

While the D. pteridifolia emergence problem is characteristic of this group as a whole, the poor result with ASG 29 is distinctly unrepresentative of the otherwise reliable D. nivea species complex, which includes D. arctotidis, D. brownii, D. lindleyana, D. nana, D. preissii, D. stenoprion and D. tortifolia (but not D. bipinnatifida, D. obtusa or D. mimica). The ASG 29 figure of 43% emergence represents two collections, one giving just under 43% and one just over 43%, so it is at least consistent, even if two batches is little to go on. On past experience, I believe that the problem can be attributed to the habit of this species from the southern Jarrah forest, which has underground stems, tufted foliage in scattered clumps and flowers at ground level. The seed heads are often half buried in sand, which seems to subject the seed to both insect attack and, perhaps more importantly, making it more prone to infection by soil microorganisms.

In a similar vein, I have found it very difficult to collect good seed of D. preissii and, to some extent, D. arctotidis, Dryandra species nova aff. D. nivea (ASG 26) from the Northern sandplain and D. nana, all of which have the same underground stem and half-buried seed heads as ASG 29. Indeed, the quite good average germinability results with the first three of these species are balanced by one bad result. In the case of D. preissii, one of three batches gave 17% emergence (only 6 planted); for D. arctotidis one of three was 0% (only five planted); for ASG 26 one figure was 0% (only 3 planted) along with two other better figures. The fact that the poor results in these three cases coincided with very low numbers of seeds is an indication that seed collection was difficult and only a few half-rotted heads were found. The otherwise good results in 1984 and 1987 plantings with the subterranean stemmed D. nivea group, I attribute to my improved collection techniques - avoiding buried flower heads (or luck in finding better plants). The clumping forms of D. nivea, including D. brownii and D. stenoprion do not present the same challenge of avoiding diseased seed and results seem consistently better.

Flowering and fruiting at ground level appears to also offer an explanation for the low emergence figures for at least two species in the D. pteridifolia complex. Like D. blechnifolia from the Stirlings, its Northern Sandplain counterpart, species nova ASG 22 (Margaret Pieroni form 7, Newsletter 16), has underground stems and flowers at ground level. The second, Dryandra species nova aff. D. calophylla (ASG 3) looks like a halfway point between D. calophylla (general spreading habit, flowers thrust out ahead of foliage, rather than at the base of leaf clumps) and D. blechnifolia (appearance of flowers (type A) - though these are smaller than D. blechnifolia). In Newsletter 16 this is Margaret Pieroni form 5. In contrast, the other two problem species in terms of germinability are shrubby plants. Dryandra species nova aff. D. drummondii (ASG 38) is a distinctively upright form of this generally low clumped plant and reaches at least a metre in height. Dryandra nervosa can be quite tall, forming a mound up to 1.5 metres high and twice as wide (Margaret Pieroni form 1). The flowers of both species are carried on the ends of upright branches and in mature plants are respectively 0.5 and 1.0 metres off the ground for the two species, eliminating the ground effect from calculations.

Seven other members of the D. pteridifolia group were involved in the sowings. The "true" D. pteridifolia (Margaret Pieroni form 2) is a prostrate species with its "type B" flowers at ground level often buried in the sand of the Southern Sandplain. Dryandra species nova aff. D. nervosa (ASG 39) is a variable species across its range in the south eastern wheatbelt and southern sandplain. All forms lack underground stems, though the habit can differ. Margaret Pieroni describes this as form 8 in Newsletter 16 and the differences in the forms are reviewed in Section 3.6.

The "true" species of Dryandra shanklandiorum is from east of Cadoux and the species listed as aff. D. shanklandiorum is from Bruce Rock to Mount Hampton. The latter is the plant grown widely in eastern Australia from Nindethana seed labelled D. preissii. Both forms are strongly upright species with "type B" flowers well above ground level. The "true" D. drummondii (type B flowers) and "true" D. calophylla were also sown, as was Dryandra species nova aff. D. calophylla (ASG 41) from Woodanilling, which has the growth and flowering habit of D. calophylla but revolute blue grey leaves more like the "true" D. pteridifolia. The flowers of the latter are, however, decidedly of the shaving-brush (type A) variety like D. blechnifolia, D. nervosa and indeed D. calophylla. Of species discussed the Newsletter 16 article on the forms of D. pteridifolia, the "true" D. blechnifolia and Dryandra sp. nova aff. D. nervosa (ASG 14) (Margaret Pieroni form 6) were the only two that did not feature in the 1984 and 1987 seed plantings and are missing from Table 2.

The percentage emergence observations of the prostrate vs. the upright forms of the D. pteridifolia species complex are summarised below.

PROSTRATE

aff. D. blechnifolia (22): 37.9% (only one batch)

aff. D. calophylla (3): 48.8% (58 and 33%)

D. pteridifolia: 55.6% (67 and 52%)

aff. D. calophylla (41): 79.6% (only one batch)

D. calophylla: 80.6% (only one batch)

UPRIGHT

aff. D. drummondii (38): 41.4% (only one batch)

D. nervosa: 45.5% (50 and 44%)

D. drummondii: 58.1% (only one batch)

D. shanklandiorum: 66.7% (only one batch)

aff. D. nervosa: (39) 71.4% (100, 96 and 36%)

aff. D. shanklandiorum: 77.8% (only one batch)

None of the taxa showed particularly high germinability but the prostrate species did not especially appear to be at a disadvantage, downplaying the possible importance of soil microorganisms and rotting of seed. A more consistent explanation for the overall modest success with this group may well lie in the large fleshy seed, which contrasts clearly with the seeds of other Dryandra species. Comparisons of seed shape and size are taken up in Section 3.3.

Embedded in the D. pteridifolia group emergence data is an intriguing question about Dryandra species nova aff. D. nervosa (ASG 39), which Margaret Pieroni describes as form 8. The raw data show two collections giving 96% (26/27) and 100% (33/33) emergence and one at 36% (16/45), all three being 1987 observations. In all cases the batch size was high so the results could be considered reliable. While there are many reasons involving health or treatment of seed that could be advanced to explain even such a profound difference, there is a possibility that the results reflect an intrinsic difference. The 96 and 100% emergence was achieved with collections made east of Harrismith and west of Ongerup respectively. The form is the same at these two localities, though it tends to be larger and more robust on the gravelly wheatbelt soils around Wickepin than on the sandplain soils between Ongerup and Ravensthorpe. This is the "more green" leafed form mentioned by Margaret. The foliage is, in fact, a very distinctive dark, almost olive green colour, with long rusty hairs on the underside of the leaf. In general appearance it resembles D.nervosa and can get to the same size - up to 1.5 x 2.0 metres - with flowers carried high up, as with D. nervosa to a metre above ground. The leaves, however, have revolute (rolled over and turned under) edges, though not as tubular as some of the D. pteridifolia family. Robustness, strength and a degree of coarseness is the overall impression of this plant. The Tarin Rock form, in contrast, is a light delicate and frothy thing with finer lobed, blue green leaves and almost lacey miniature floral leaves surrounding flowers and seed heads. I cannot recall really large specimens of this form and the plant forms a basal clump with leaves radiating outward - much more like the common form of D. drummondii in habit than D. nervosa. A plant of this dryandra in our Montrose garden is now over 15 years old (our original "D. pteridifolia"!) and has always been, and is now, a superb specimen, but only 75-80cm tall and 65-70cm wide. Nearly all the height is leaf, the basal clump of stem and flowers is no more than 15cm above ground. It has shown no tendency to develop creeping stems, which eliminates any suggestion that it could be ASG 14 (Margaret Pieroni 6).

I am inclined to interpret the data as supporting a view that there are two different species lumped together into ASG 39 that should be separated at least as varieties. As I recall, when collecting the seed there was an abundance of good quality material at Tarin Rock and the plants were young and vigorous. Perhaps some seed heads were slightly immature and this has affected emergence? Collection dates suggest otherwise as the seed was collected on 29/6/86 and therefore must have been from May to July 1985 flowering, as it would have been too obviously immature if from 1986. My views on the relationship of the two forms of ASG 39 predated the 1987 emergence data. To me, the southern plants are but one small step removed from D. nervosa, while the Tarin Rock to Lake Grace plants seem more like a clump forming relative of the Newdegate prostrate ASG 14, which has very similar (type A) flowers and well-formed floral leaves. Notwithstanding these similarities, the latter is unequivocally a creeping plant, with underground branches of several metres, so the distinction between those two appears well founded. How or whether Alex George can separate them all is entirely a matter of taxonomic conventions. Horticulturally, however, the two forms of ASG 39 are different, probably in terms of germinability as well as appearance!

Ten batches of seed sown were collected from garden-grown dryandras from Victoria. The performance of this seed was generally comparable to field collected material as below:

aff. D. armata (11): 29/39, 67%
no field comparison

aff. D. armata (20): 11/12, 92%
compare with 27/28, 96% from field

aff. D. conferta (33): 14/20, 70%
compare with field average 124/171, 73%

D. formosa: 32/36, 89%
compare with 9/27, 33% and 18/21, 86%

aff. D. hewardiana (1): 16/20, 80%
no field comparison

aff. D. polycephala (7): 10/29, 35%
compare with field average 80/102, 78%

D. praemorsa: 21/23, 66%
no field comparison

D. quercifolia: 15/25, 60%
compare with field average 58/104, 56%

D. subpinnatifida: 17/24, 71%
compare with 5/19, 26%

D. tenuifolia: 42/48, 87%
compare with 19/30, 63% and 8/11, 73%

In general, the figures appeared quite comparable between the field and garden collections of the same species. In two cases, the garden-grown material appeared superior, D. tenuifolia and, in particular, D. subpinnatifida. The latter is attributed to a failure to discover good parent material in the field. With Dryandra species nova aff. D. polycephala (ASG 7) the reverse was true and no explanation can be offered. One particular similarity should be pointed out. Dryandra species nova aff. D. armata ASG 20 is a medium sized prickly subject from north of Three Springs. It features in both Table 2 as the fifth most successful dryandra in germinability and fills sixth place amongst the speediest to emerge in Table 4. The comparison of field and garden seed is shown below:

aff D. armata (20)	Seed Source Field	Garden
Percent emergence	96%	92%
% emerged by day 30	93%	82%
% emerged by day 40	100%	100%

The correlation is excellent when it is considered what an extreme example this species set in the tests by both speed and reliability criteria, when compared with the rest of the genus. It would seem that these characteristics are an intrinsic property of the seed of each species no matter where it is grown!

Two species that showed low emergence figures in Table 3 remain for discussion and both also feature in the Table 4 list of species that were slow to emerge (relative to their final emergence figures). They are D. concinna, which topped the table of lowest germinability, and D. foliolata. Both are medium to tall shrubs from the Stirling Range upper slopes. Possible explanations are reviewed in detail in Section 3.5. For the purpose of this section of the discussion, it should be recorded that the health and vigour of seeds or parent plants of both species appeared exemplary at the time of collection. As they are both species which retain seed there is no reason to suspect an under-maturity or over-maturity problem. The same statements can be made for D. longifolia, D. foliosissima and for D. mimica and its relative ASG 16, which were the other key species that were highlighted in Table 4 as slow to emerge.

3.2 Age and Storage of Seed

Most of the 1984 planting was of seed collected on an Alcock-Knight expedition between August and October 1981, with an equal number donated by Evan Clucas who was in the west over the same period. A smaller number date from January and October 1983 Alcock visits to the west. No differences in speed of emergence or overall germinability could be attributed to age of seed from the 1984 assessments.

The 1987 planting consisted of a few examples of these earlier collections but also from Alcock journeys westward in January and October '83, September '84, March and October '85, September and November '86 and April '87. The other large collection made on behalf of the Study Group that provided some seed for 1987, was by John and Chris Cullen after the visit in August/September 1985 which discovered ASG 50, though the seed used in 1987 was a re-collection. Also sown in 1987 were five collections of D. nivea or aff. D. nivea and one of D. tenuifolia made by Pat Urbonas in 1977(?) and two batches of "old Study Group seed": one D. nivea or aff. D. nivea, one D. fraseri and one D. ashbyi. The latter carried no date, but were certainly collected no later than 1979. An early Alcock collection of D. shuttleworthiana from 1979 was also sown that year. The emergence data from the 1987 plantings of 1970's seed are summarised below and compared with other 1987 results.

Pat Urbonas collections (1977?)

D. nivea (or aff.)	PU33	8/8	100%)	
"	PU34	18/18	100%)	91%
"	PU47	6/7	86%)	
"	PU50	10/13	77%)	

Compare with total of other D. nivea and aff. D. nivea collected 1981-1987 of 202/269 - 75%

D. tenuifolia	PU2	8/11	72%

Compare with D. tenufolia collected 10-'84 : 42/48 - 87%

"Old Study Group Seed"

D. ashbyi : 21/27 - 78%

Compare with total of other D. ashbyi collected 1984-1986 : 113/134 - 84%

D. fraseri : 1/43 - 2%

Compare with total of other D. fraseri collected 1983-1986 : 52/54-100%

D. nivea : 22/22-100%

Compare with D. nivea as above:202/269 - 75%

1979 D. shuttleworthiana

D. shuttleworthiana : 5/6 - 83%

Compare with D. shuttleworthiana collected 9-'84 : 4/10 - 40%

Ten years in storage has appeared to mature the D. nivea collections nicely, for all of the aged collections have provided higher than average germination, including three of 100%! The figures for the D. ashbyi and D. tenuifolia seed reveal no differences attributable to storage, but the "old Study Group" D. fraseri appears to have badly deteriorated. This seed looked to be perfectly sound, though there remains the possibility that it was subject to some specific stress during long storage. The results do, however, suggest that age or poor storage conditions can eventually catch up with dryandra seed. The D. fraseri statistic was excluded from the summary data presented in Tables 1-4.

The good emergence from the 1979 D. shuttleworthiana seed comes as a surprise, even allowing for the fact that the figures are derived from only six seeds sown. This species features in Table 3 with the sixth lowest germinability record and might be expected to reflect any deleterious effect of seed ageing. This and other results certainly suggest that the age of the seed is not a significant factor affecting emergence in these trials. Further examination of the data on species with less than 50% emergence confirms that there are no results that can be attributed to old seed. In summary, the age at time of sowing of seed in the case of the twelve species with lowest germinability in Table 3 was:

D. concinna : 3 years

aff. D. serratuloides (45) : 2 years

D. sessilis var. (52) : 3 years

aff. D. blechnifolia (22) : 3 years

D. lindleyana : 3 and 4 years

D. shuttleworthiana : 1, 3, 4 and 8 years

aff. D. drummondii (38) : 2 years

aff. D. nivea (29) : 3 and 4 years

D. nervosa : 3 years

aff. D. calophylla (3) : 3 years and 1 month

D. subpinnatifida : 1 and 3 years

D. foliolata : 3 years

There were five instances in these data where more than one collection of different ages was sown. Overall, there was no clear indication of the oldest giving a worse result. The five comparisons, giving youngest first and oldest last, were : D. lindleyana 11/28 - 39% (3 yr), 2/4 - 50% (4 yr); D. shuttleworthiana 10/41 - 24% (1 yr), 16/28 - 57% (3 yr), 4/10 - 40% (4 yr) and 5/6 - 83% (8 yr); Dryandra species nova aff. D. nivea (ASG 29) 7/16 - 44% (3 yr), 3/7 - 43% (4 yr); Dryandra species nova aff. D. calophylla (ASG 3) 5/15 33% (1 month), 15/26 - 58% (3 yr); D. subpinnatifida 17/24 - 70.8% (1 yr), 3/17 - 18% (3 yr). Superior results with fresh seed occurred only in the last case, but this was more than counterbalanced by strong trends towards the reverse from most of the others, especially D. lindleyana, D. shuttleworthiana and the species nova aff. D. calophylla (ASG 3).

On only two occasions was the same batch of seed sown in both 1984 and 1987. These were both from the Evan Clucas 1981 expedition, when both were collected for the first time so far as we know. One was Dryandra species nova aff. D. falcata (ASG 48)* from the Stirling Ranges. In tall Stirlings thicket, this species grows tall and thin, the thickly leaved branches resembling a Saguaro cactus - but it can be pruned to shape in a garden. The resemblance to D. falcata is superficial, confined to leaf shape and general flower appearance. The real family relationship of this species is called into question when the seed is examined. In contrast to the naked seed of D. falcata and species nova aff. D. falcata (ASG 9), the Stirlings species has the biggest seed capsule in the genus, up to 1.5cm across and very heavily built. Finding the seed on the plants is not easy, they seem a favoured food source for black cockatoos. The second species where direct comparisons were possible was a super-compact form of D. nivea (or aff. D. nivea) from Kojonup. The results were:

	1984	1987
aff. D. falcata (48) :	23/23 - 100%	10/12 - 83%
aff. D. nivea (?) :	23/44 - 52%	7/12 - 70%

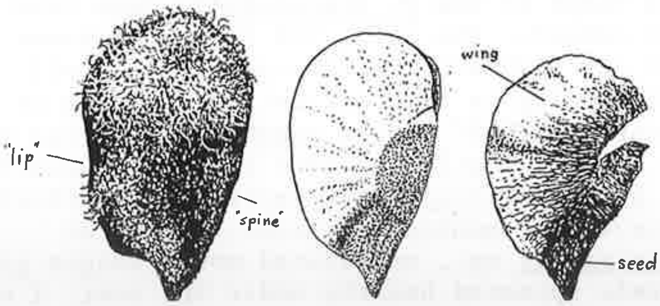
Once again, older seed does not seem to constitute any major problem, at least under the circumstances that the Study Group seed was stored. The applicability of the data to storage of extracted seed is unknown. I would speculate that germinability would not be as good, but would expect that such seed would remain viable for at least three years. Seed kept in capsules looks to have a shelf-life of at least ten years.

3.3 Characteristics of Capsules and Seeds

Dryandra seeds come in a variety of shapes and sizes. Excluding the thin membraneous wing that most species have, the majority of seeds are between 2 and 4mm long and slightly less across. Depending on how they slot into the woody capsule, they can be pyramidal, spinning-top shaped, oval or rounded, usually flattened along the axis parallel with the side of the capsule. Five species: D. falcata and its Northern Sandplain counterpart, ASG 9, D. serratuloides and its southern relative ASG 45 and the "Kamballup dryandra", have no capsule, but are enclosed in a thin skin which is covered in silky hairs. These exceptions aside, the remainder have a flat-sided, more or less woody capsule, apparently designed for two seeds by having either a woody or papery separator dividing it down the middle. In practice, very few actually set two seeds. Where the separator is woody, it is sculptured to surround the seed on the side where it lodges, while the other has a rather vestigial crease where the seed should be. A flattened outline of the seed plus its wing is usually all that remains of the second of the pair.

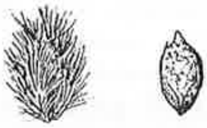
*Footnote: This is not Dryandra sp. aff. D. falcata of the Rob Sainsbury book; that is Dryandra species nova aff. D. armata (ASG 10).

DRYANDRA SEEDS

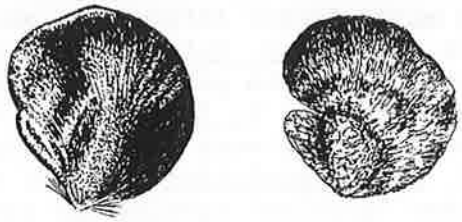


D. quercifolia

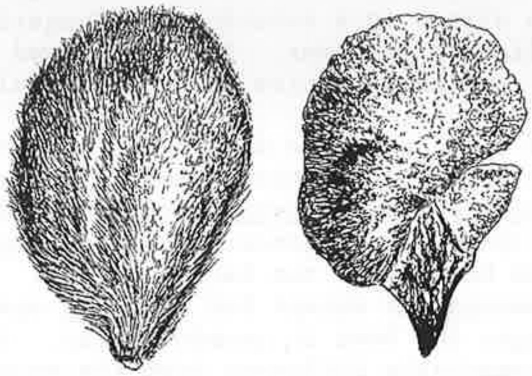
capsule separator seed



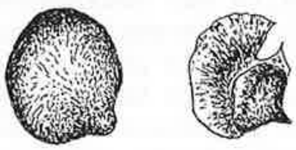
D. falcata



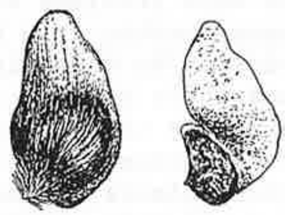
D. pteridifolia



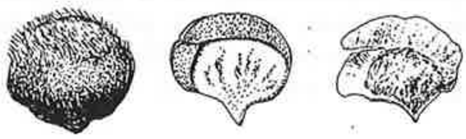
D. sp. ASG 48



D. polycephala

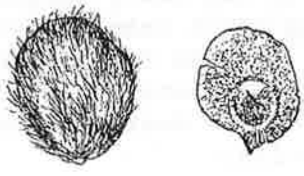


D. concinna



D. carlinoides

capsule separator seed



D. cuneata

X2.

The D. pteridifolia family tend to extremes in terms of seed size. Seeds are disc shaped, very much flattened, up to 1cm in diameter but only a millimetre thick. They tend to take up a higher proportion of the capsule than most species, leaving room for only a thin skirting wing. Often, there are two seeds to a capsule, with a thin filmy separator in between. I believe that the shape of the D. pteridifolia type seed and capsule contributes to the poor emergence record. The large but thin seed seems to struggle to emerge even when covered with the lightest sprinkling of sandy soil. In many cases, the seedlings seem to have difficulty in breaking out or shedding of the seed coat. I would recommend experimenting with half peeled seeds to encourage a more rapid process of germination in the hope that exhaustion of seed reserves could be avoided. I also have a concern that the D. pteridifolia type capsule is inefficient in protecting the seed from disease. I have on a number occasions, opened an apparently sound seed only to find an Aspergillus sp., or related mould fungus growing on the surface of the seed. While the seeds appeared healthy under the coat, I cannot believe that this contamination helps. I have never observed this phenomenon with any other dryandra. In the 1987 sowing, the seed of D. pteridifolia and related species were dipped in a solution of "Fongarid" and "Benlate" in an attempt to reduce the risk of disease problems. Results showed no marked improvement over 1984 but in both years the regular fungicide drenching should have reduced the hazard.

Seed size and shape does not appear to have been a major factor influencing success with any other species. Some with very small seeds, such as D. pulchella and the D. polycephala/D. hewardiana group were amongst the top in both germination percentage and speed of emergence, but so was Dryandra species nova aff. D. falcata (ASG 48) which has one of the largest seeds. The naked seeded species were consistently fast to emerge and except for Dryandra species nova aff. D. serratuloides (ASG 45) were amongst the best in germinability. None of the other "problem" species has seed that is remarkably different from the majority of the genus and explanations for poor performance need to be sought elsewhere.

It is also difficult to read anything into the germinability or speed of emergence observations that can be attributable to the ease or difficulty of extraction. No species posed such problems with extraction that seed health was endangered. As mechanical means rather than heat was used, any potential differential sensitivity to heat was avoided. No comparison is offered between heat induced and mechanical extraction and there remains a question whether some species may have a requirement for a heat stimulus to break seed domancy and allow it to germinate. It seems reasonable to anticipate that a genus geared to recolonising burnt areas after fire kills the parent plants may have evolved such a mechanism. However, the generally satisfactory germination results tend to suggest that heat is not a requirement. The key problem species D. concinna and D. foliolata, for which an explanation is yet to be offered are, in fact, amongst the worst equipped to require the stimulus of heat. The capsules of both species are in the lowest quartile with regard to the thickness of capsule wall and the seed would almost certainly be killed if exposed to intense heat. Some of the heavy shelled species like D. quercifolia, D. obtusa and D. tridentata would seem better candidates to respond favourably to a fire stimulus to germination. On the evidence available, heat does not seem to be a prerequisite to trigger seed and there is on an incidental association through the fires which are a major cause of the death of parent plants and trigger the release of seed of most Dryandra species.

3.4 Seed Dispersal - Annual Release or Release After Fire

With the majority of species of Dryandra, not a single seed is released from the capsules until the death of the plant or at least of the branch on which the seed is borne. While all causes of death is equally effective, it is accepted that, in the wild, fire is the most common cause and that this genus, like many other Proteaceae is adapted to retain seed for release onto a fresh seed bed created by fire.

The dryandras that do not fit this pattern shed seeds when ripe, usually within 4-8 months of flowering. The species are D. hewardiana, D. squarrosa and D. polycephala and all of their undescribed relatives; D. nobilis and the related D. stuposa; D. sessilis in all its forms and D. praemorsa. The majority of these species are medium to tall shrubs of lateritic gravel areas of woodland in the Darling Plateau. The exception that proves the rule is the species nova aff. D. polycephala (ASG 15), which is found on laterite ridges of the Northern Sandplain, usually within 50km of the coast. Dryandra species nova aff. D. polycephala (ASG 7) is a forest inhabiting species north of Perth but ventures out onto laterite rises and coastal sands around Moore River. Dryandra sessilis is distributed widely along the western coastal plains and Northern Sandplain but is also a strong competitor on laterite gravel of the Darling Plateau forest. The association of the seed shedding species with an open forest habitat is generally consistent, though whether there is any evolutionary logic behind the connection is less apparent.

The seed shedding species seem less well adapted to fire cycles than their seed retaining relatives, which conserve all of their seed until the death of the parent plant. If fire is the cause of death, as it often is, then the seeds are safe within thick walled capsules in the fruits. By contrast, the capsules of the seed shedding dryandras are the thinnest of the genus. Moreover, the summer bushfire season is likely to find a large proportion of seed shaken free of the capsules and scattered widely over the ground. While these naked seeds have no in-built protection from fire, a proportion is probably safe as fires race quickly over the sparse ground vegetation; many would be wedged in cracks in the ground or in the lee of laterite pebbles or rocks. The greatest risk would be late spring, early summer fires which could kill the parent plants before the new seasons seed has matured, thus eliminating all prospect of regeneration. Perhaps the open wandoo or powderbark woodlands of the Darling Plateau are less prone to fire, or fires come later in the season than in other dryandra habitats and the more fire sensitive species have been more successful there for this reason.

The seed shedding group as a whole are particularly floriferous, producing large numbers of generally small flowers which reliably set large numbers of seed. Rapid germination of seed was a particular feature of both the 1984 and 1987 sowings of these species, with three varieties of D. sessilis, one of each of D. nobilis, D. polycephala and Dryandra species nova aff. D. hewardiana (ASG 25) providing six of the fastest twelve to emerge - a disproportionately high figure. This readiness to germinate confirms that the autumn rains would see all seed responding and no carry-over to the following year. The fertility and high germinability of the seed shedding dryandras could help overcome by sheer numbers the relative disadvantage in sensitivity to fire. The profuse seed production and annual shedding must equally help these species colonise burnt areas from outside. The seed of this group of dryandras is comparatively small for the genus and wind dispersal could well carry the winged seed for several hundred metres. Success in this regard would depend on the fires being localised rather than area wide.

The lateritic gravel of the forest areas where these dryandras are found is a relatively hostile environment not suited to many species of the Western Australian or, indeed, any other flora. It may be that the seed shedding dryandras have enough general competitive advantages to dominate in these areas where fire may not be the major evolutionary force. Dryandra polycephala, D. nobilis, D. stuposa and the forest forms of D. sessilis are certainly very successful species in their chosen habitat and form dominant stands where they do occur. The degree to which this is attributable to their fecundity, fire survival, wind dispersal or simply their exceptional competitiveness on lateritic sites is not at all clear, but elements of each appear to be involved.

3.5 Speed of Emergence - The Need for a Trigger?

Possible explanations for the notably poor emergence figures of D. concinna and D. foliolata have yet to be offered. These two species are also prominent in the slow to emerge bracket, D. concinna in equal first place and D. foliolata in fourth. The problem with the two Stirling Range species was compounded by the fact that the other three species of the slowest five, D. longifolia, Dryandra species nova aff. D. mimica (ASG 16) and D. foliosissima all started to come up in earnest over the next 10 days and by day 50 and especially sixty days from sowing, D. concinna and D. foliolata were clearly consolidated as difficult species. The progressive figures at fifty and sixty days from sowing are presented in Table 5. These are milestones towards 100% of the emergence achieved by day 90, though of course this may itself represent a low percentage relative to seeds sown.

Table 5

Speed of Emergence

Long Term Problems

	Emergence By Day 50 (As % of Total Emergence)	Emergence By Day 60 (As % of Total Emergence)	Emergence By Day 90 (As % of Seed Sown)
concinna	0	0	23.9
foliolata	14.3	33.3	48.9
aff. mimica (16)	15.1	50.9	89.8
mimica	20.7	62.1	76.3
longifolia	5.0	85.0	74.1
foliosissima	40.0	95.0	87.0
aff. ferruginea (35)	48.0	92	72.2
aff. ferruginea (34)	84.8	96.8	72.1
aff. plumosa (47)	64.0	100	80.6
aff. conferta (5)	66.6	100	86.8
arctotidis	85.0	100	71.4
drummondii	90.9	100	61.6

The first seedlings to emerge from the two batches of D. concinna sown in 1984 did not appear until late June. Even by the end of June, when the seedlings were tubed-up and the pots discarded, there were more than three quarters of seedlings yet to appear. Two thirds of the D. foliolata to emerge also took more than sixty days and by day 90, half of the seeds sown had shown no sign of stirring, though they still appear sound when exhumed. In fact, the 14.3% and 33.3% progressive figures for D. foliolata refer only to the 1987 sowing in which 67% of seed had emerged by day 90. The two batches sown of this species in 1984, failed to produce a single seedling within three months.

As discussed in earlier Sections, seed quality issues do not seem to provide any clue to the problem with D. concinna and D. foliolata. I believe that the reason for my poor results is that both species require a cold stimulus - vernalisation - before germination will commence. This process is well documented in many plants from cold climates in other parts of the world and is an evolutionary adaptation to ensure germination in spring, usually to avoid the stress of winter chill on young seedlings. While I am convinced that this is the reason, my conviction can only be supported by anecdotal evidence.

In autumn of 1986, we planted another large collection of dryandra seed for which inadequate records on emergence were kept. What, nevertheless, stood out was that in late July, some four months after sowing and two months after the remaining dryandras had finished emergence, the pot of Dryandra species nova aff. D. plumosa (ASG 12) finally showed some sign of life. In fact, well over half of the seeds sown came through within days of the first one appearing. This medium-sized shrub with foliage somewhat like D. plumosa and brown wooly bracts around the flowers (to ward off the cold and damp?) is only found on the summit of Bluff Knoll in the Stirling Ranges. No proof yet of a need for cold stimulus, but the pattern matched an earlier experience with Banksia saxicola, which comes only from a few localities in the Grampians and Wilson's Promontory in Victoria. The form from near the summit of Mt. Victoria had also burst to life only after winter chills had arrived following an autumn sowing.

When I next planted this species, I carried out a vernalisation experiment. Stratification with slightly damp peat moss/sand and storage in a refrigerator for several months in late spring, after which the pots were transferred outside, induced emergence in summer where none was achieved with seed sown at the same time but kept outside over the same period.

While the Stirling Peaks do not get quite as cold as the Grampians or Wilson's Promontory, they are a colder place over winter than most of Western Australia and moisture is never far away over much of spring. Spring seems altogether a more favoured time for seedling emergence and I believe that all three of these Stirling Range Dryandra species has evolved a process to ensure seed remains dormant until chilled by lower winter temperatures. A situation could be imagined that a summer fire releases seed in autumn but that the seed would not respond to autumn and winter rains and only initiate germination in Spring. My recommendation when planting the three species is to either sow in very late autumn and leave for six months before abandoning hope or to give stratification treatment prior to sowing. One to two months refrigeration (not freezing) in a just moist condition in 50:50 peat moss : sand should break the dormancy.

The segregation of D. mimica and its undescribed relative ASG 16 as next slowest to emerge has struck me as surprising, at least partially because the overall emergence was good and I had not identified either of them as problem species. Moreover, the two come from such different locations that evolutionary link that would provide benefits from slow emergence seems unlikely. Dryandra mimica is recorded from three widely separated locations. In the south it occurs in the Whicher Range near Busselton and in the north around Mogumber, with the only other recording coming from the outer suburbs of Perth near Orange Grove. I have not observed the Whicher Range plants but the other two populations are in low sandy country. The seed sown (in 1987) was from Mogumber. In complete contrast, ASG 16 comes from the barren laterite tops of several peaks in the Ironcap Range back of beyond, north west of Lake King. The seed sown in 1987 was from Hatter Hill. I am totally unable to speculate on whether there is an evolutionary trigger than delays emergence with these two species, but I am of the opinion that the speed of emergence data are sufficiently different from the remaining 103-108 taxa to reflect a genuine distinction.

The fifth contender in the slow emergence stakes was D. longifolia, the seed sown in 1987 being collected in 1985 from Thistle Cove, growing in the lee of of huge granite boulders some 200 to 300 metres from the Southern Ocean. The pattern of emergence was very distinct. The precise figures were : at 52 days from sowing one emerged, by 60 days from sowing 17 had emerged and three more by 82 days. While the length of the delay in emergence was not a severe as for D. concinna or D. foliolata, there was certainly an abrupt turning-on of germination when it did commence and this looked like the breaking of a dormancy mechanism. The change was more abrupt than D. mimica and aff. D. mimica ASG 16, which were slow but relatively steady from about day 40 onwards.

It is interesting to compare the Thistle Cove D. longifolia with the Dryandra species aff. D. longifolia from the Dempster Head lookout on the outskirts of Esperance. The first seedling of the latter emerged 31 days after sowing and the bulk (77%) were through by 43 days. This was certainly a different emergence pattern to its Thistle Cove counterpart and gives no hint of any special trigger requirement. Whether or not the decumbent Dempster Head plant with its spiky leaves and even spikier seed heads can be separated taxonomically from the upright softer leaved Thistle Cove plants is again one of botanical convention, but as with Dryandra species nova aff. D. nervosa (ASG 39) the emergence data give some support for a distinction to be made between two forms/varieties/species.

In comparison with the slowest five on Table 5, the remaining species appear to have germinated only slightly less quickly than average. All started to come up quite quickly between forty and fifty days after sowing and achieved virtually their full potential, and near average percentage emergence overall (except D. drummondii), by sixty days after emergence. As with D. mimica and ASG 16, the appearance of two very closely related species giving similar results invites closer inspection. Dryandra species nova aff. D. ferruginea ASG 34 and ASG 35 are both creeping, underground-stemmed species from the northern edges of the southern wheatbelt and Frank Hann National Park, in the area near Newdegate and Lake King. The observations are the mean of three batches of ASG 34 (one in 1984) and two of ASG 35 (both in 1987). These results were closest to the "true" D. ferruginea but appeared quite different from some of the undescribed species in the D. ferruginea species complex. For instance, the Tutanning giant flowered form (ASG 19), the Stirling Range miniature ASG 49, the Ravensthorpe Range species ASG 36 and, especially, the large greyleaf form from near Corrigin (ASG 40) were substantially faster.

3.6 Post-emergence Survival

The post-emergence survival records show more variation between the two years of the tests and less conformity within species or groups of taxa than the germinability or speed of emergence results. In part this can be attributed to the variability in data derived from the sometimes small samples involved. The observations are presented as a percentage of the emerged seedlings (not total seed sown) and this denominator was often in single figures. However, I believe this measure is truly much less reflective of intrinsic differences between dryandras and do not believe that the data could bear too much interpretation, even where the sample sizes were large enough to inspire confidence in data accuracy. Basing conclusions on species or related taxa where sample sizes were in excess of 100 seedlings emerged, there are some differences that may provide at least a guide to some of the easier and harder to grow groups of dryandras. The three with highest losses were: the D. conferta group and D. plumosa (with ASG 47 included, having 99 seeds emerged) at 11% and the D. ferruginea group at 9%. All three were substantially higher than the next in line which was the D. armata complex at 5%. The only outstandingly good statistic from the species or combinations with 100 or more seeds was from the D. falcata group with 1%. Amongst the species or species combinations not to suffer any losses, and where sample sizes were high, if not 100, were: D. mimica (82 seedlings) Dryandra species nova aff. D. nervosa (ASG 39) (75 seedlings); D. nobilis varieties (74 seedlings); D. shanklandiorum varieties (69 seedlings) and D. serratuloides and ASG 45 (63 seedlings).

Individuals from the D. conferta and D. ferruginea groups provided four of the twelve lowest single species survival figures in Table 3. In this table were also D. shuttleworthiana and D. tridentata, species that I have found difficult to grow and which encourages me to think that these figures may help point to dryandras that cause problems in cultivation. However, individual results can be subject to a number of distorting influences. The D. subulata figure of 22% loss is largely due to the death of 13/34 in 1987 from an incidence of damping-off that was not caught in time. In the 1984 sowing, 19/20 D. subulata seedlings survived and I do not regard this species as generally difficult.

With the exception of D. shuttleworthiana and Dryandra species nova aff. D. blechnifolia (ASG 22), all of the the species listed as having highest losses were at least average in terms of emergence. Indeed, in comparing the Table 3 data on emergence, Dryandra species nova aff. D. conferta (ASG 21) tops both the highest emergence and highest post-emergence losses lists and the related species ASG 31 appears in the same ranking of the two columns. The same pattern was evident with both Dryandra species nova aff. D. ferruginea ASG 40 and ASG 36, which each showed more than 80% emergence, as did D. subulata, while suffering heavy decline thereafter. In the overall data, the D. conferta and D. ferruginea complexes showed, with D. ashbyi, the highest emergence percentages and, with D. plumosa the highest post-emergence losses.

The explanation of this apparent connection could be that the very high strike with these species may have indirectly encouraged the onset of damping-off as a result of the slightly increased humidity around more densely packed seedlings. More likely, the abundance of seedlings may have promoted an inclination to not bother with tubing-up the last few weakest seedlings, which would have been treated as more precious if they were represented less abundantly!

Although the D. pteridifolia group proved difficult in terms of emergence, some at least appeared very reliable thereafter, as seems to be the situation in general cultivation. The apparently low survival rate of ASG 22 and D. nervosa is perhaps subject to distortion as a result of the low emergence performance. They represent two losses from eleven and one from ten. One seedling of Dryandra species nova aff. D. calophylla (ASG 3) was lost out of twenty emerged and three D. drummondii out of 53. The remainder of the broad D. pteridifolia species complex failed to sustain a loss from a total of 220 seedlings. It has been suggested that the large seeds of this group of dryandras constitute a disadvantage in terms of emergence for a number of reasons. Once the seedlings have emerged, it seems the food reserves held in the large seeds may help post-emergence survival.

However, the evidence for this principle to apply in a general sense seems lacking. Amongst the species that gave trouble between emergence and tubing-up were D. conferta, D. shuttleworthiana and D. tridentata, which have large seeds, along with the group D. ferruginea and D. stuposa, which have small seeds. Seed size does not seem to have any consistent effect on survival after emergence. After removing once-off effects such as occurred with D. subulata and perhaps the overcrowding (or too much success) with D. ferruginea and D. conferta, it looks as if there is at least some indication that reliable species, from a cultivation point of view, stand out quite early - the D. pteridifolia group, D. fraseri, D. ashbyi, D. nivea all look safe.

3.7 Habit

While there are likely to be individual instances in the overall results that could point to a connection between size category or habit and the germinability, pattern of emergence or post-emergence survival data, the link is almost certainly an effect and not a cause. The one indirect effect that has been highlighted is the increased frequency of poor quality seed from prostrate species, where seed heads are at or below ground level.

Eliminating all of the extraneous effects to enable a direct comparison with habit as the only variable is extremely difficult. There are only two cases where a direct comparison can be made between varieties of the same species which have different stature. The five metre tall giant form of D. ashbyi from the Three Springs area, ASG 23, gave higher emergence (95%) than the remainder of D. ashbyi collections (80%), while the prostrate form of D. tenuifolia (ASG 53) with 60% emergence was somewhat behind the upright and cascading forms of the same species at 77%. These results however, were within the range of variation shown by different collections of the same taxon where habit is identical and I believe that there is no intrinsic difference attributable to habit, for individual species or more generally across the genus.

3.8 Habitat

Dryandras have evolved in a wide variety of habitats. Lateritic gravel never seems far away, but the overall landscape can be sandplains in either the north or the south, the forests of the Darling Plateau, the plains of the wheatbelt, the slopes of the Stirling Ranges and the Barrens or lateritic hilltops wherever they occur. Small, medium and, less often, tall dryandras can be found in each of these habitats.

As with habit, most of the observed differences in raising them from seed cannot be directly explained as evolutionary features associated with their habitat. The exception is the apparent necessity for a cold stimulus to trigger the emergence of the Stirling Range montane species D. concinna, D. foliolata (and Dryandra species nova aff. D. plumosa ASG 12), considered to be an adaptation to avoid germination in autumn/winter where conditions are cold and often wet. Other Stirling Range species which extend to the lower slopes did not appear to need any cold stimulus and germinability, speed of emergence and post-emergence survival were generally up with the average.

The preponderance of the seed shedding species in the forest flora, where this may be an adaptation to less frequent or less intense fires, also resulted in observable differences, notably in the speed of emergence, although these species also have high germinability. This appears more likely to be an indirect effect of habit rather than a direct cause of the observations. East of the Darling Range, into the hills and slopes of the Darling Plateau wheatbelt, the species range diversifies, especially where lateritic islands occur in the oceans of cereals and pastures. Most species from these areas are unremarkable as far as seed raising is concerned, provided seed is of good quality (D. subpinnatifida the prime problem in 1984).

Species from the Northern and Southern sandplains appear to feature more strongly amongst the troublesome species than those of other origins. There is likely a personal prejudice in this statement because of my difficulties over the years with the Northern Sandplain dryandras. Dryandra shuttleworthiana and D. tridentata are particular examples, but others are amongst my least favourite, particularly D. tortifolia and Dryandra species nova aff. D. blechnifolia (ASG 22). After D. lindleyana, which is found predominantly from coastal sands near Perth, and Dryandra species nova aff. D. nivea (ASG 29), a Jarrah Forest species, D. tortifolia showed the lowest germinability results amongst the broad D. nivea grouping. ASG 22 was the worst of the of the D. pteridifolia complex both of terms of emergence percentage and post-emergence losses.

Three species could provide a clue to whether plants from the Northern Sandplain are expecially difficult. Forms of D. speciosa, D. serratuloides and D. drummondii occur in the heart of the Northern Sandplain and then slightly different forms pop up hundreds of miles away with nothing in between - or at least not now that farming has done away with so much of the vegetation. Dryandra speciosa occurs near Merredin and D. serratuloides near Moora on the Darling Plateau wheatbelt, while D. drummondii is known primarily from the Stirlings to Bremer Bay, with the upright ASG 38 more inland from Nyabing and surrounding areas. Alas, the matrix of results is far from complete although the results do tend to weaken any theory of problems deriving specifically from Sandplain varieties. The only seed sown in 1984 and 1987 of D. speciosa and D. serratuloides were of the Northern sandplains forms, both of which, especially D. speciosa came up very well. The northern form of D. drummondii at 54% emergence was little worse than two Stirling Range collections with 64% and 63% emergence or ASG 38 with 41%. The data is too incomplete to establish a principle, but it appears that at least for seed emergence characteristics separate evolution has not differentiated the isolated populations and no light can be shed on whether Northern Sandplain species are especially difficult.

The Southern Sandplain and the Barrens hold fewer fears whether rational or irrational. None of the especially bad results in terms of germinability came from these areas, D. pteridifolia at 56% and D. cuneata at 59% being the worst, with neither being bad enough to warrant concern.

4. CONCLUSIONS

The results from two separate seed raising studies established that the species of Dryandra tested were all at least reasonable subjects for growing from seed. The data showed strong agreement between the two years that records were kept. Three parameters were measured; germinability (percentage emergence); pattern of emergence (speed of emergence) and post-emergence survival. The germinability and, in particular, pattern of emergence data provided strong evidence of differences between species. In the former case, the differences appeared to relate almost entirely to the health and vigour of individual batches of seed used. However, the pattern of emergence appears to be characteristic for each Dryandra species/species complex and does not markedly change with the source or quality of seed. Observations of post-emergence losses provided little differentiation between species and only superficial indications of reliability at the seedling stage.

The Dryandra species which shed seed between seasons were consistently the fastest dryandras to emerge, both in terms of first seedlings to appear and in the date by which emergence was complete. The majority of other species were grouped together in a middle band but two species in particular, D. concinna and D. foliolata, showed long delays before germination was initiated. The delay has been attributed to a vernalisation requirement to ensure that these two Stirling Range montane species germinate in spring after winter chills have passed. Three other species showed delays in emergence but less evidence of the need for a trigger to break dormancy. Dryandra longfolia (from Thistle Cove) but not Dryandra species aff. D. longifolia (Dempster Head) was considerably delayed before a rapid emergence phase was initiated. Two related species D. mimica and Dryandra species nova aff. D. mimica (ASG 16), although coming from markedly different habitats, were both subject to substantially delayed emergence.

The majority of records of lower than average germinability related to poor quality seed, most often the result of collections being made with little opportunity to be selective. In these situations, few seeds were available from isolated/drought stressed/insect affected parents and this is reflected in results. Specific instances are cited of poor germinability from collections where seed quality was known to be poor, contrasted with at least average figures from seed sources known to be better. A number of such cases involved prostrate species with underground stems and seed heads which often become buried by shifting sands. These species appear to present a higher risk of poor quality seed, subject to rots by soil microorganisms. Seed up to ten years old showed no evidence of a decline in germinability. While this comment may only apply to seed stored in capsules, it is encouraging that there is no major problem in this area.

Dryandra species belonging to the D. pteridifolia complex were disproportionately represented in the lowest germinability category. It is believed that this failing is attributable to the large seed of these species proving inefficient under the conditions of the studies. Difficulties with splitting of seed coat or in the seedling levering itself clear of covering soil, and/or higher susceptibility to damping-off fungi are put forward as contributing factors. The use of effective fungicides and experiments with partial peeling of the seed coat are recommended.

Certain species from the Northern Sandplain appeared prominent both in records of low germinability and or high post-emergence losses. There may be some indication that cultivation in the relatively cool and humid climate of Melbourne may not suit species from such an arid environment. The data in this regard are far from conclusive and it may well be that this observation holds true for all species of Dryandra!

Details are given of the practices followed to achieve the generally satisfactory emergence results and recommendations are made for seed collecting, storage, extraction, sowing and growing on. Apart from the specific vernalisation requirement for D. concinna and D. foliolata, the major prerequisite of successful seed raising is seed of good health and high vigour. It is particularly recommended that the growing mixture be free draining, that humidity is minimised at all times and that specific attention is paid to disease control. While it may not be always possible to actively maintain soil disease control for established plants, the benefits of good drainage and low humidity (or at least good air drainage and high doses of sunshine) are just as paramount in importance to ensure healthy, vigorous, flowering dryandras, as they are for seed raising.

K T Alcock Nov 90