RESEARCH

IMPACT OF CLIMATE CHANGE ON THE DISTRIBUTION OF THE GENUS *DRYANDRA*

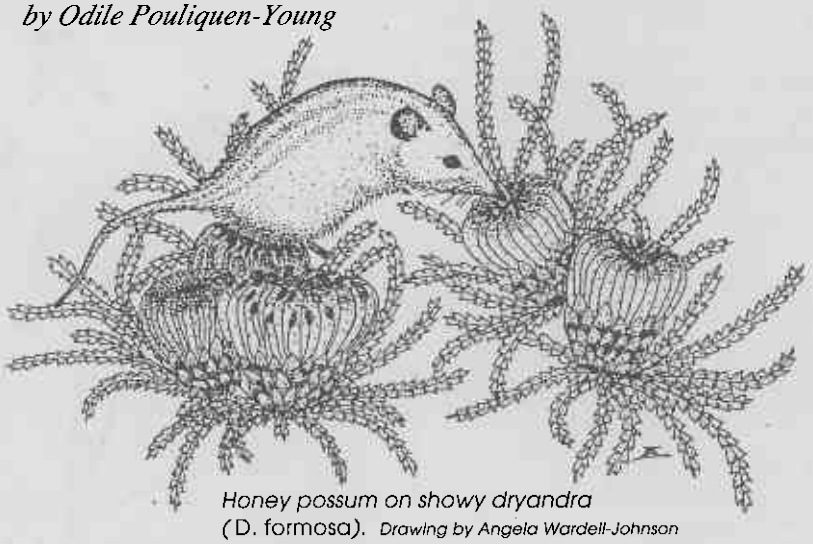
by Odile Pouliquen-Young

CLIMATE change has the potential to become the most important threat to the world's biodiversity to date. Realistically, it is unlikely that the rate of production of anthropogenic greenhouse gases is going to be slowed down enough in the next 50 years to delay climate change. We should seriously begin to look now at what impacts climate change will have on the natural environment, especially in those parts of the world with a high endemic biodiversity such as the south-west of WA.

The immediate consequence of the enhanced greenhouse effect is to increase global temperatures. This in turn has an impact on regional temperatures and rainfall patterns, in short on regional climate. Some researchers are arguing that climate change could already be responsible for the lower rainfall patters of the last few decades in the south-west. Whether climate change has already put its mark on the region, or is going to be of more importance in the next century, is a matter of debate. Whatever the case, those species which have evolved to take advantage of specific climate patterns such as the Mediterranean winter rainfall, will have to adapt to changing climatic conditions.

In 1996, CSIRO climate change scenario based on estimates of greenhouse gas emission rates indicates a further decrease in rainfall over the whole south-west, particularly in summer. There is a marked southern shift of the regional isotherms and a contraction of the lower temperature areas of the region. As global temperature increases, changes in the region's climate are more noticeable.

Because we do not know much about the requirements of native plants, the easiest way to estimate the impact that climate change may have on native species is to look at how the species' distribution will respond to changes in local temperature and rainfall. To do that, the species' current distribution was matched to a set of climatic variables using a specialised computer software specifically designed for Australian conditions, to define the species' climatic envelope. This envelope is much larger than the species' real distribution which is usually constrained by other things than just climate. For plants, the main element constricting the distribution of species is the type of soils that it prefers. By adding for each species its preferred soils to its preferred climate, we obtained what we called the species' 'environmental envelope'.



Honey possum on showy dryandra (D. formosa). Drawing by Angela Wardell-Johnson

We use the CSIRO climate change scenario with three different global temperature increases: 0.5°C, 1°C and 2°C depending on the rates of emission of the greenhouse gases, an increase of +0.5°C should occur between 2015 and 2045, while a +2°C would happen between 2070 and post-2100. For each of these global temperature increases, the CSIRO scenario gives the expected changes in local temperature and rainfall over grid boxes of about 125 km by 125 km.

Our results on the 92 species of the endemic genus *Dryandra* indicate that we can expect a range of responses to climate change (Table 1). It is clear that a reduction of the species' distribution areas is

Table 1. Responses of Dryandra *species to climate change (n=92). Overlap between current and predicted environmental envelopes: *>75%, **<50% Some species display multiple types of responses to climate change.*

Response types	Number of species		
	+ 0.5°C	+ 1°C	+ 2°C
1. Decline within current environmental envelope*	64	36	16
2. Decline with partial** or total displacement between current and predicted environmental envelopes	2	4	12
3. Total disappearance	26	43	61
4. Increase in environmental envelope area	1	1	0
5. Contracts from the north	55	40	27
6. Contracts from the east	15	20	7

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by far the most common response. There is also a trend for the impacts of climate change to be more severe as global temperatures increase.

Most researchers expect that species will move to track their preferred climate. After the last glaciation, trees and other plant species from Europe and North America migrated northwards (and some are still doing so) as ice sheets have retreated. Our results do not show any such large scale movement. Instead, 26 dryandras disappear at +0.5°C, raising to 61 species at +2°C. These species will not be able to find their preferred environmental envelope anywhere in WA. This important result is due to the fact that most dryandras have very specific soil requirements and that their preferred soil types are not widespread. Because of the southern shift of the isotherms, the decline that most species experience within their current environmental envelope occurs through a contraction of the northern part of their distributions.

Another important result is the influence the size of the species' current environmental envelope has on its vulnerability to climate change. All the species whose environmental envelopes are currently less than 1000 sq km disappear very rapidly (Table 2). The largest species are much more 'resistant' to climate change: no species with a current environmental envelope covering more than 50 000 sq km disappear at +0.5°C and only one of these species disappears at +2°C.

This result is due to two factors: (1) the larger the environmental envelope of a species, the wider the range of climate parameters it can be found under and the less likely climate change will exceed these parameters completely; (2) the larger the species' distribution, the more soil types it is likely to prefer so that its predicted climatic envelope under climate change is going to coincide with at least some of its preferred soil types.

This effect of size is independent of location. Whether from the south or north of the region, species with a very small environmental envelope disappear extremely quickly.

Table 2. Impact of three global temperature increases on Dryandra *species ranked by area of current environmental envelope.*

Current area (sq km)	No. of species at current climate	No. of species which disappear at:		
		+0.5°C	+1°C	+2°C
0 - 1 000	25	25 (100%)	25 (100%)	25 (100%)
1 000 - 5 000	14	1 (7%)	9 (64%)	12 (86%)
5 000 - 10 000	22	0	6 (27%)	15 (68%)
10 000 - 50 000	21	0	3 (14%)	8 (38%)
> 50 000	10	0	0	1 (10%)
Total	92	26	43	61

Table 3. Proportion of Dryandra *species whose environmental envelope lies within native vegetation areas over 50 ha, under current climate and three global temperature increases.*

Proportion of the species' environmental envelope within native vegetation areas	Proportion of species within native vegetation areas at:			
	Current climate	+0.5°C	+1°C	+2°C
0 - 25%	44%)	43%)	43%)	51%)
25 - 50%	41%) 85%	48%) 91%	47%) 90%	26%) 77%
50 - 75%	5%	6%	4%	6%
75 - 100%	9%	4%	6%	17%
Number of species	92	66	49	31

85% of dryandras have less than 50% of their current environmental envelope within large blocks of native vegetation (State Forests, protected areas and remnant vegetation areas of more than 50 ha). Because the species do not move markedly with climate change, this proportion does not change much under climate change (Table 3). What reserve system we have now will need to be greatly upgraded if we want to improve the conservation status of surviving dryandras under climate change.

If we assume that the responses of the distribution of dryandras to climate change are likely to be the same for other endemic plants in the south-west, this study has several implications for the development of conservation strategies aimed at counter-acting climate change in the region. Some of these implications are noted below.

- Rare or restricted plant species endemic to the south-west will be extremely vulnerable to climate change: they will suffer most and much earlier than more widely distributed species.
- The current centres of plant diversity in the south-west (Stirling Ranges and Northern Sandplains) are also very vulnerable because of the high number of restricted species found only there.
- Ecosystems with a high plant diversity are not going to gain species by migration, but instead are going to lose all their restricted species first.
- Because most plant species do not move under climate change, expanding the current system of reserves should take precedence over the design of corridors across the region.
- Because species migration is unlikely, it is not possible to define specific climatic refuges where species may concentrate under climate change. However, our study indicates that the Stirling Range region may act as a climatic refuge for those species currently extending eastwards along the south coast.

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- This study did not take into account the ecological and physiological adaptability of species. We assumed that the current distribution of dryandras coincide precisely with their rainfall and temperature requirements for reproduction and/or regeneration. However it is well known that plant species can live and reproduce under a wider range of climatic conditions than those under which they are found in the wild. To improve the chances of plant species surviving climate change, some rare species from the northern part of the region could be transplanted south of their current distribution as a safeguard.

Although not a high priority threat at the moment, climate change has the potential to impact on a wide range of conservation issues including revegetation strategies, weed demography and distribution, type and amount of agricultural production (hence native vegetation clearing and management), jarrah dieback, fire patterns, native mammal re-introduction strategies, reserve location, salinity (through changes in rainfall patterns) etc. Latest climate change models indicate that the reduction in rainfall over the region could be even greater than predicted by the CSIRO 1996 model. Climate change is really a global threat both in its geographical extent and in its likely impacts. Whatever mitigation strategies against greenhouse gases, we should also be thinking of adopting strategies which will help us and our environment adapt to climate change.

Further reading: 'Dryandras – they are not all prickly shrubs' M. Pieroni, WW 2/4.

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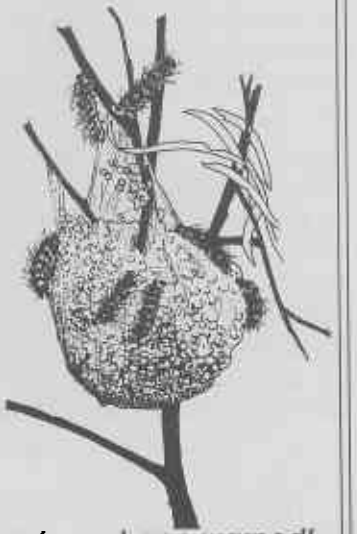

You have been warned!

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