



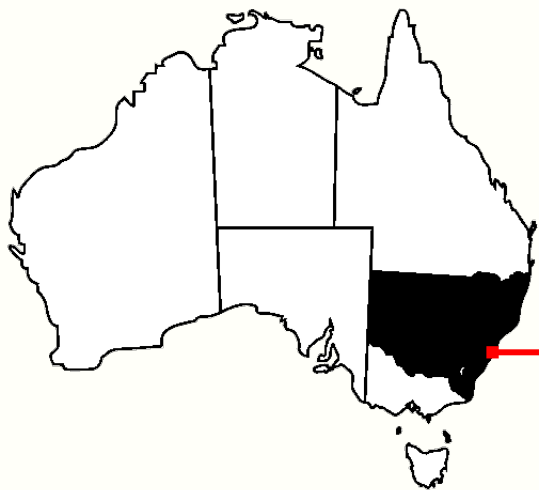
BOTANIC
GARDENS
OF SYDNEY

Banking rainforest seeds

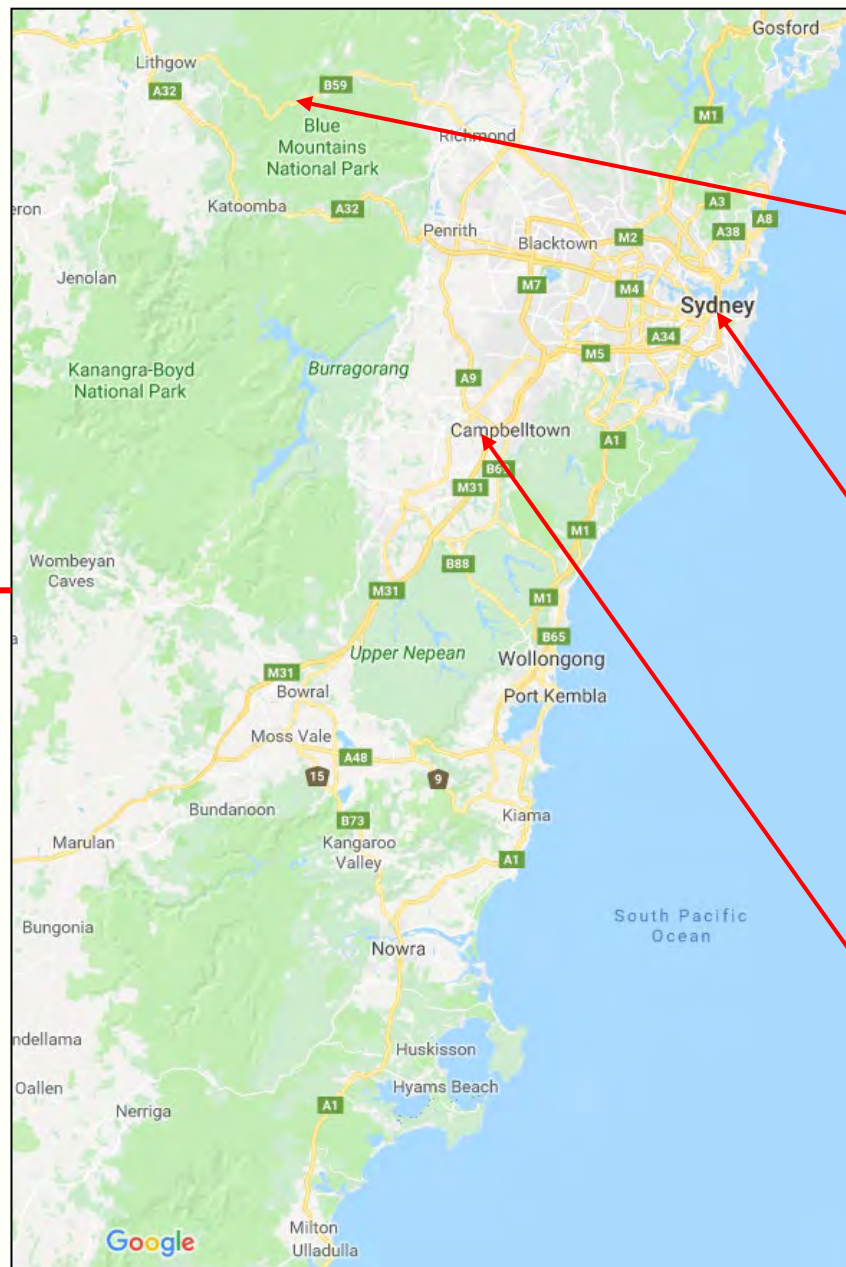




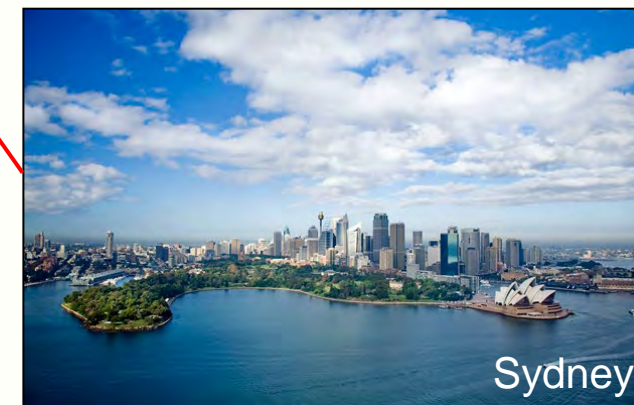
**BOTANIC
GARDENS
OF SYDNEY**



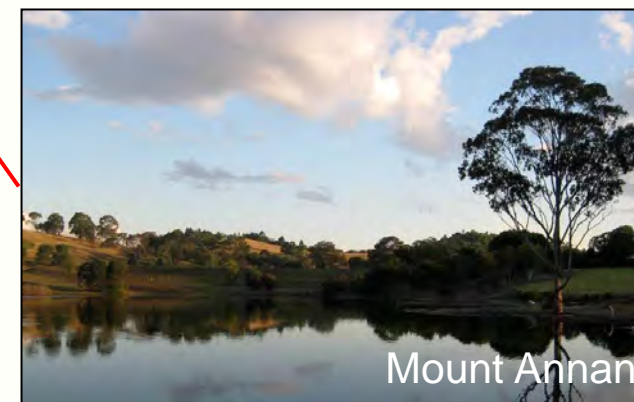
We pay our respects to all
Elders and Traditional
Custodians of the land on
which we live and work



Mount Tomah



Sydney



Mount Annan



The Australian PlantBank

Supporting in situ and ex situ conservation





The benefits of seed banking

- For conservation
 - Preserves a large amount of diversity in a very small space
 - Insurance against extinction
 - Material for translocation & research
- For restoration
 - Makes the most of collection effort
 - Evens out intermittent seed supply
 - Maintains supply through adverse events like fires and floods





Requirements for seed banking

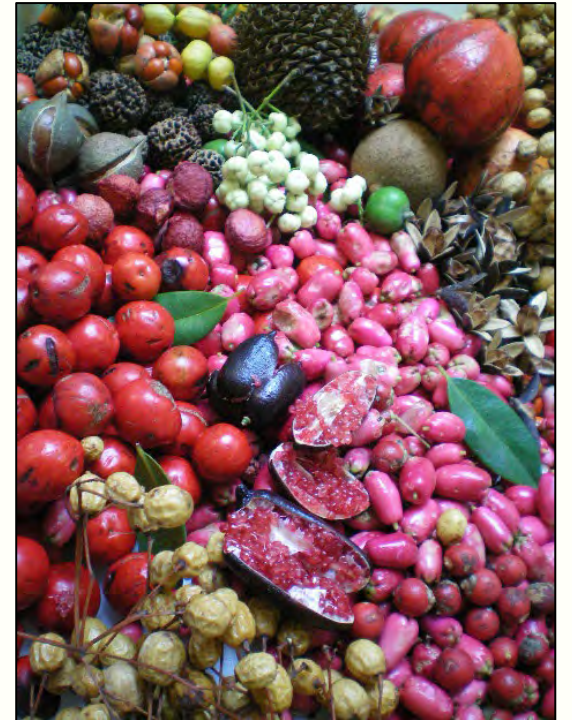
Seed banking is effective for 'orthodox' species

- tolerate drying to 3-7% moisture content
- tolerate storage at -20°C

For rainforest species

- 50% of non-pioneers predicted **sensitive to drying***
- some likely **sensitive to freezing**
- many genera not previously tested

*Tweddle et al. 2003



Can Australian rainforest seeds be banked?

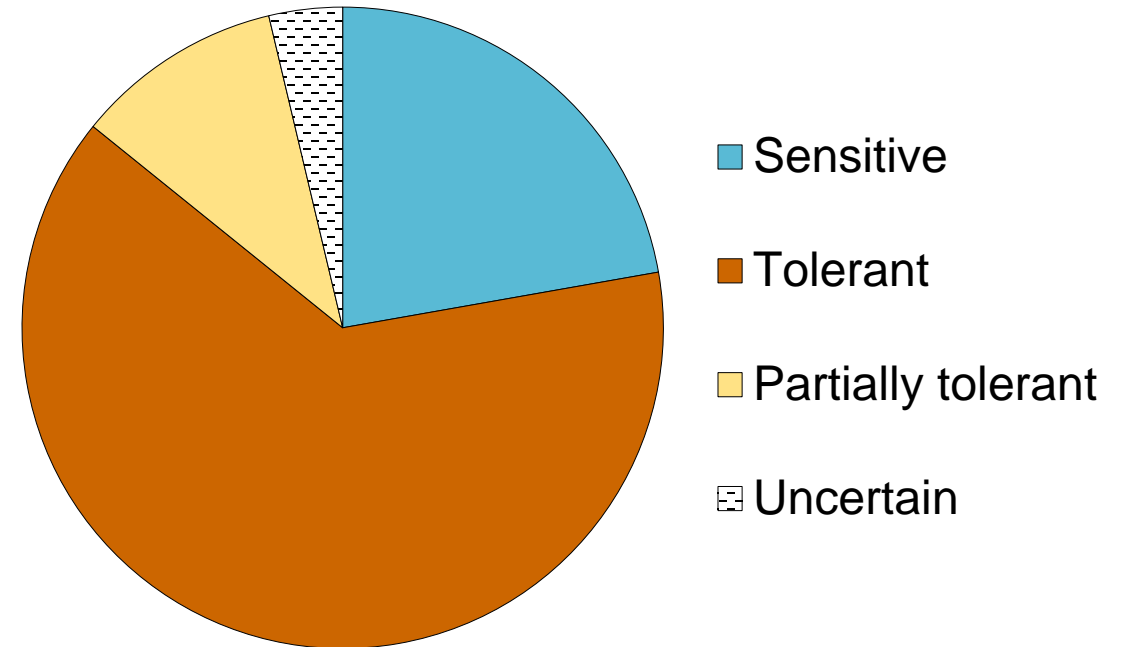
- Seed collected from across NSW
 - Subtropical, temperate, littoral & dry rainforest types
 - Variety of plant habits
 - Variety of fruit types
- Seeds germinated:
 - Fresh
 - After drying to 15% RH
 - After storage at -20°C





Can Australian rainforest seeds be banked?

- More than 300 species assessed
 - 162 species with germination > 50%
- Response to drying
 - 22% sensitive
 - 64% tolerant
 - 10% partially tolerant



Three quarters of species tested were potentially bankable

Drying sensitive genera

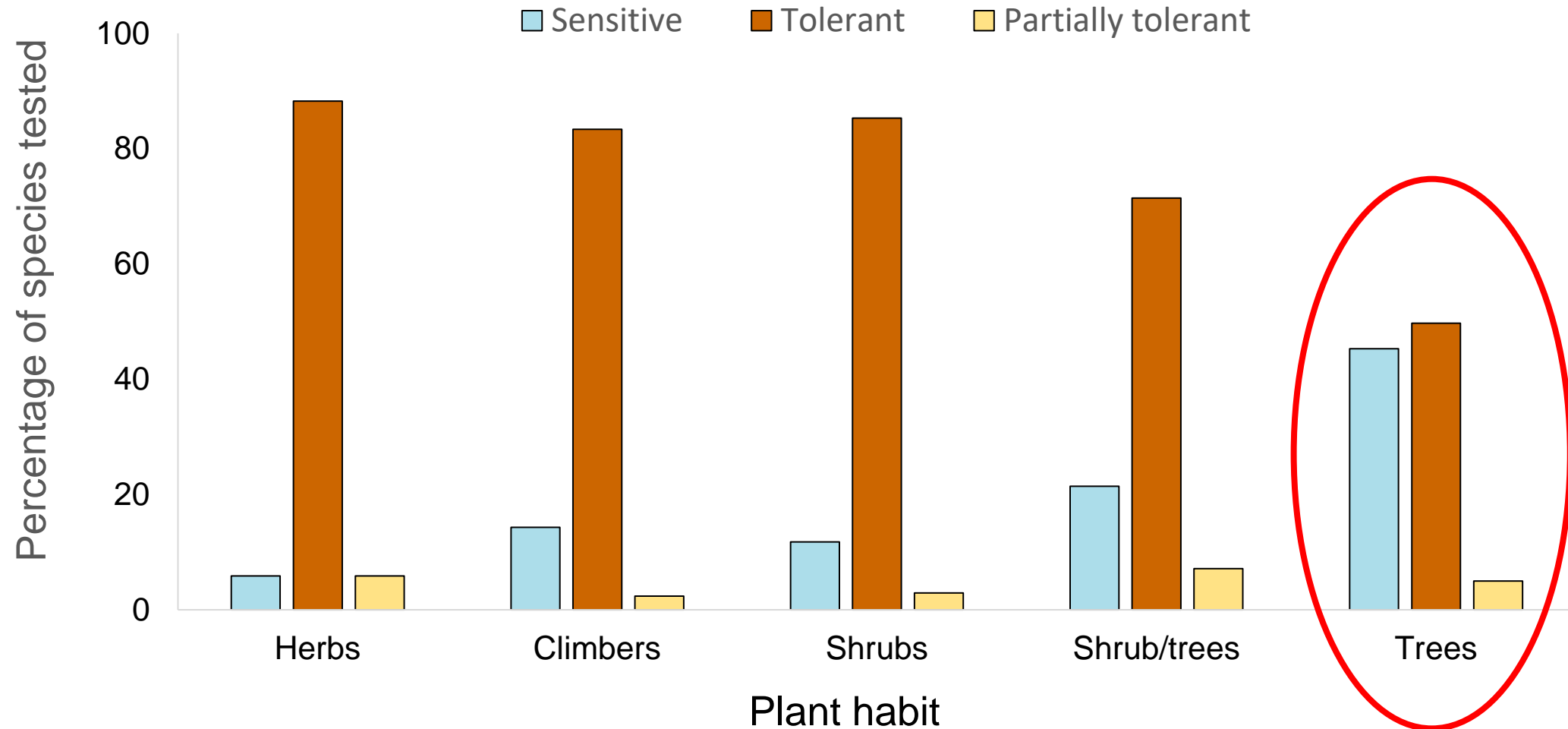
Archidendron, Argyrodendron, Castanospora, Cinnamomum, Cryptocarya (some), Cupaniopsis, Davidsonia, Diospyros (some), Dysoxylum, Elaeocarpus, Endiandra, Gymnostachys, Helicia, Hicksbeachia, Lepiderema, Linospadix, Litsea, Micromelum, Neolitsea, Pothos, Sloanea, Sterculia, Wilkiea, Maclura, Mischcarytera, Mischocarpus, Pennantia, Pilidistigma, Piper, Planchonella, Syzygium

Drying tolerant genera

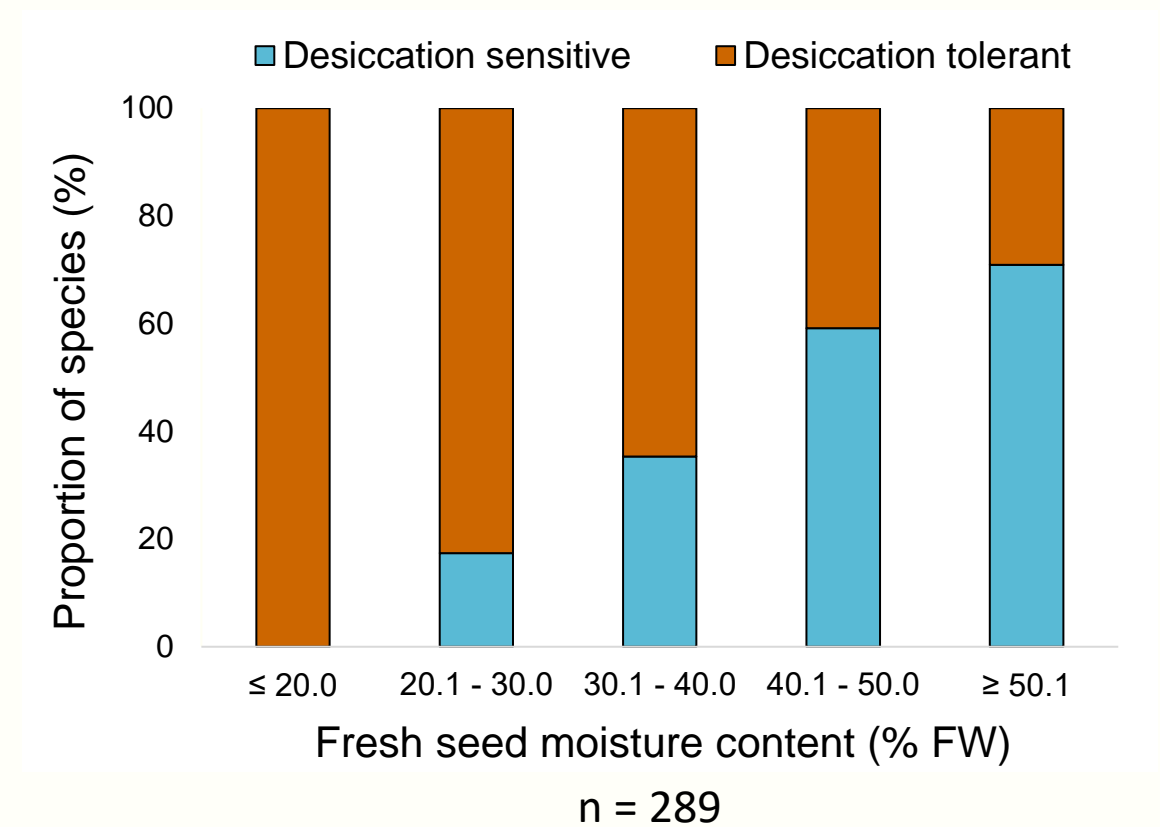
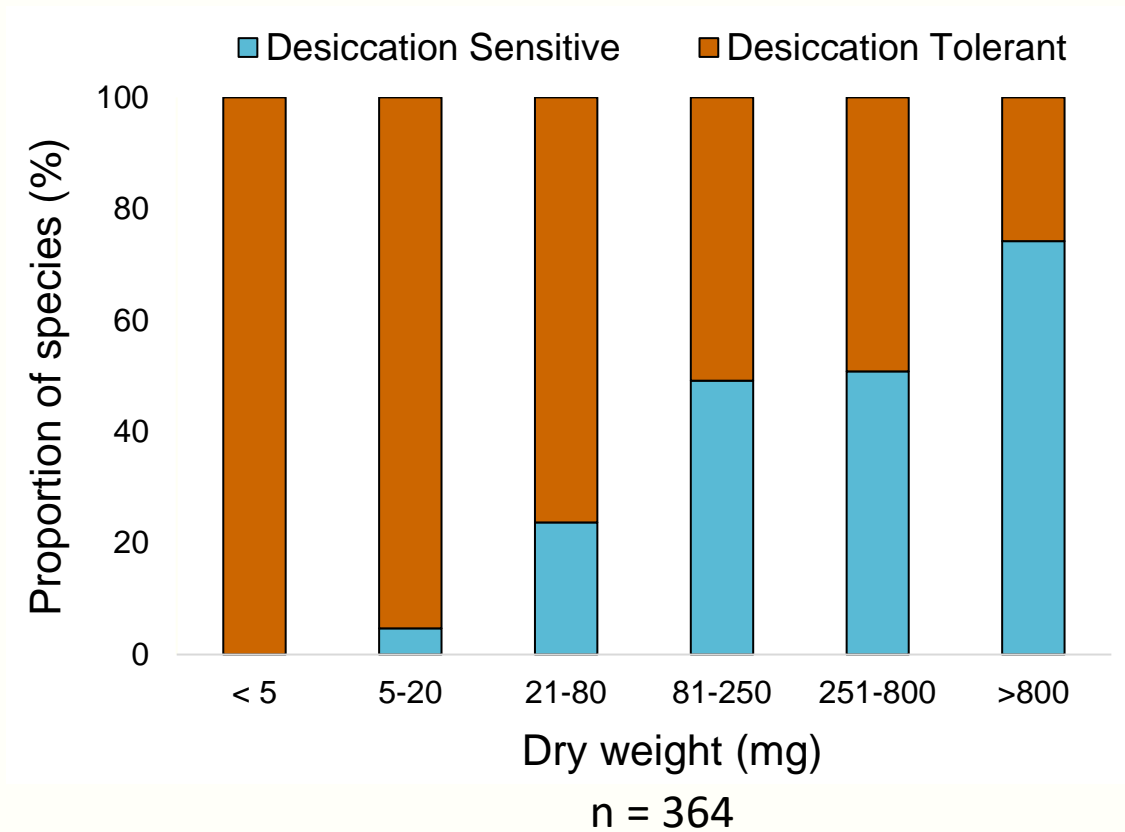
Acalypha, Ackama, Abutilon, Alstonia, Anopterus, Apophyllum, Archirhodomertus, Austromyrtus, Argophyllum, Backhousia, Baloghia, Brachychiton, Callerya, Callicarpa, Calystegia, Celastrus, Ceratopetalum, Clerodendron, Corchorus, Cordyline, Cynanchum, Cyperus, Denhamia, Dioscorea, Diospyros (some), Diplocyclos, Doryphora, Ehretia, Elaeodendron, Euroschinus, Ficus, Fieldia, Fontainea, Geitonoplesium, Gmelina, Gossia, Harnieria, Helmholtzia, Hibbertia, Hydrocotyle, Karrabina, Ludwigia, Meiogyne, Marsdenia, Melastoma, Melodinus, Mucuna, Neoastelia, Neoachmandra, Pandorea, Pararchidendron, Parsonsia, Pisonia, Plectranthus, Pollia, Polyscias, Quintinia, Rhodamnia, Rhodomyrtus, Senna, Stephania, Tabernaemontana, Tylophora, Uromyrtus, Vesselowskyia, Vittadinia



The response to drying was related to plant habit



Easily-measured seed characteristics were useful predictors of drying response



Combined data from Australia, Panama & China

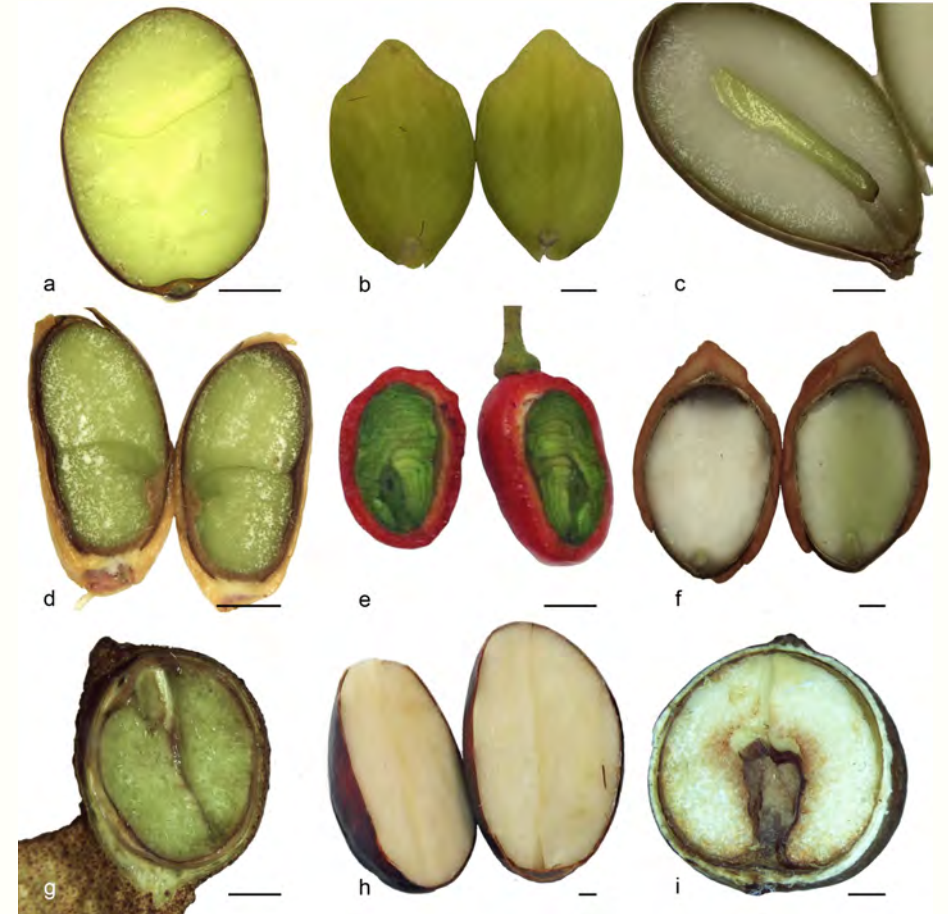
Seed morphology also gave an indication of drying response

- Sensitive to drying

- Large embryo
- Thin seed coat
- Fully developed (often green) embryos

- Tolerant of drying

- Small embryo
- Impermeable seed coat or
- High seed coat ratio



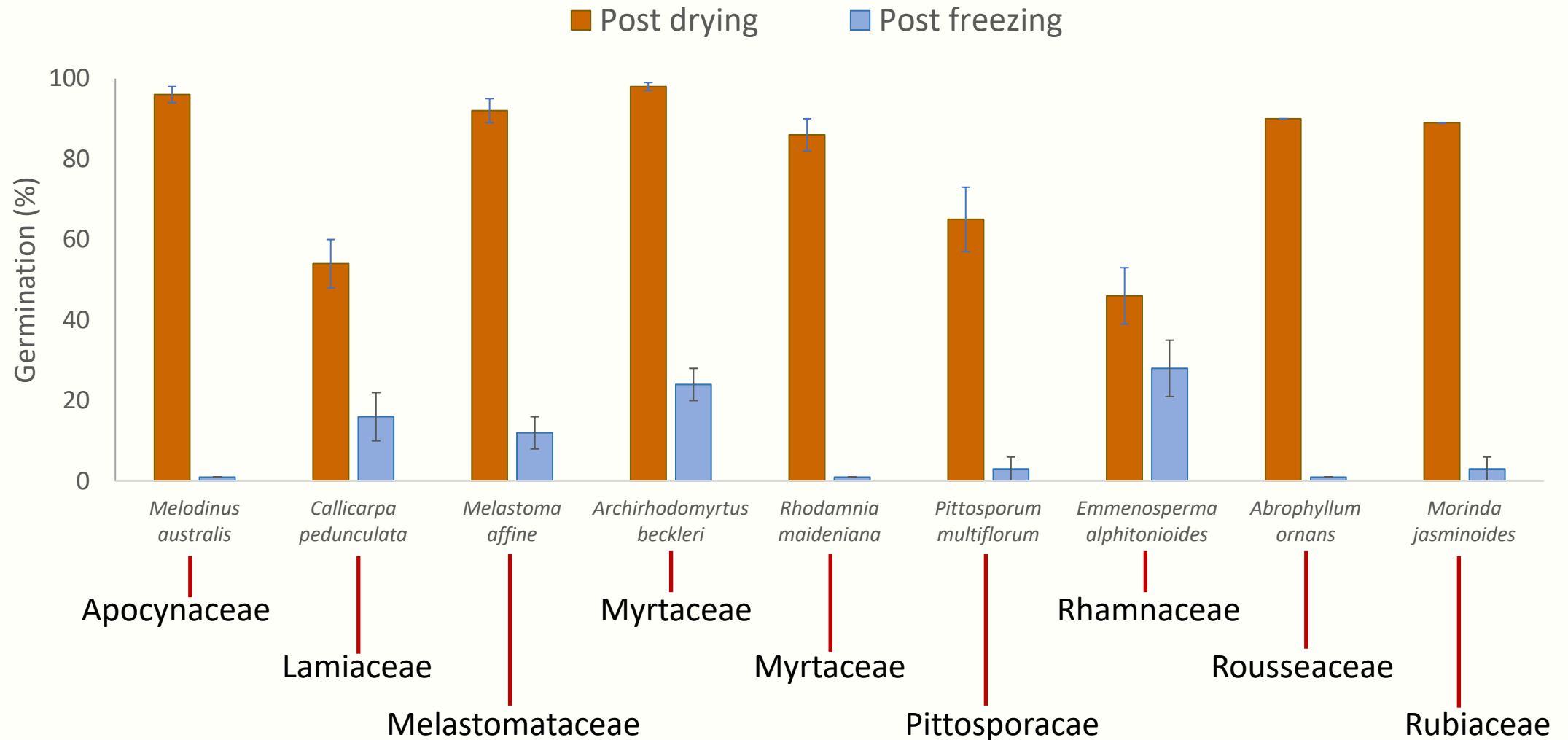
Drying-sensitive seeds
(scale bar = 2mm)



Seed characteristics were combined into a key to quickly assess response to drying

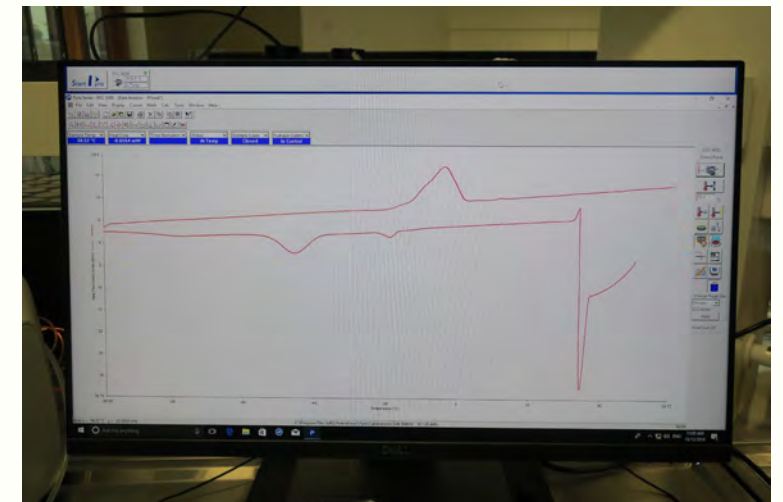
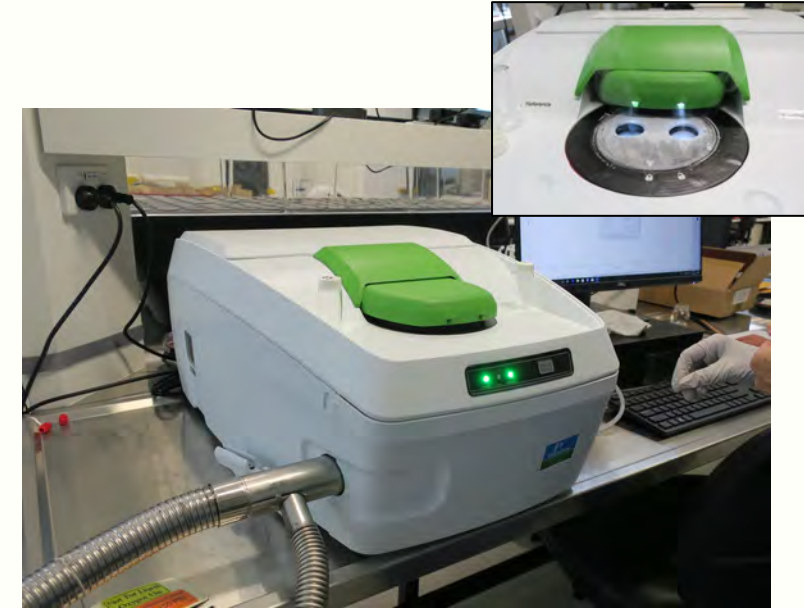
Step	Action	Outcome
1	Check for information on storage behaviour for other species in the genus	<ul style="list-style-type: none">Storage behaviour in the genus is consistently orthodox.....Likely DTStorage behaviour in the genus is consistently recalcitrant.....Likely DSStorage behaviour in the genus is inconsistent or no species tested.....Go to Step 2
2	Dissect seed with a scalpel and examine seed coat	<ul style="list-style-type: none">Seed coat hard, difficult to dissect.....Go to Step 3Seed coat soft, easy to dissect.....Go to Step 4
3	Conduct an imbibition test	<ul style="list-style-type: none">Seed coat impermeable.....Likely DTSeed coat permeable.....Go to Step 4
4	Determine oven dry weight and fresh seed moisture content (fresh weight basis).	<ul style="list-style-type: none">Dry weight < 20 mg OR moisture content < 20%.....Likely DTDry weight ≥ 20 mg AND seed moisture content ≥ 50%.....Likely DSDry weight ≥ 20 mg AND moisture content 20% to < 50%.....Go to Step 5
5	Determine seed coat ratio and calculate P_{D-S} (following Daws et al. 2006).	<ul style="list-style-type: none">$P_{D-S} < 0.01$.....Likely DT$P_{D-S} > 0.3$Likely DS$P_{D-S} \geq 0.01$ and < 0.3.....Go to Step 6
6	Inspect structure of dispersal unit and seed embryo	<ul style="list-style-type: none">Seed encased in a woody endocarp.....Likely DS or PtDTEmbryo green in colour.....Likely DS or PtDTNeither of the above.....Go to Step 7
7	Conduct seed storage behaviour experiments following Hong and Ellis (1996), Pritchard et al. (2004) or Sommerville et al. (2021)	

Some drying-tolerant species were very short-lived in storage at -20°C



Thermal analysis was used to investigate the issue

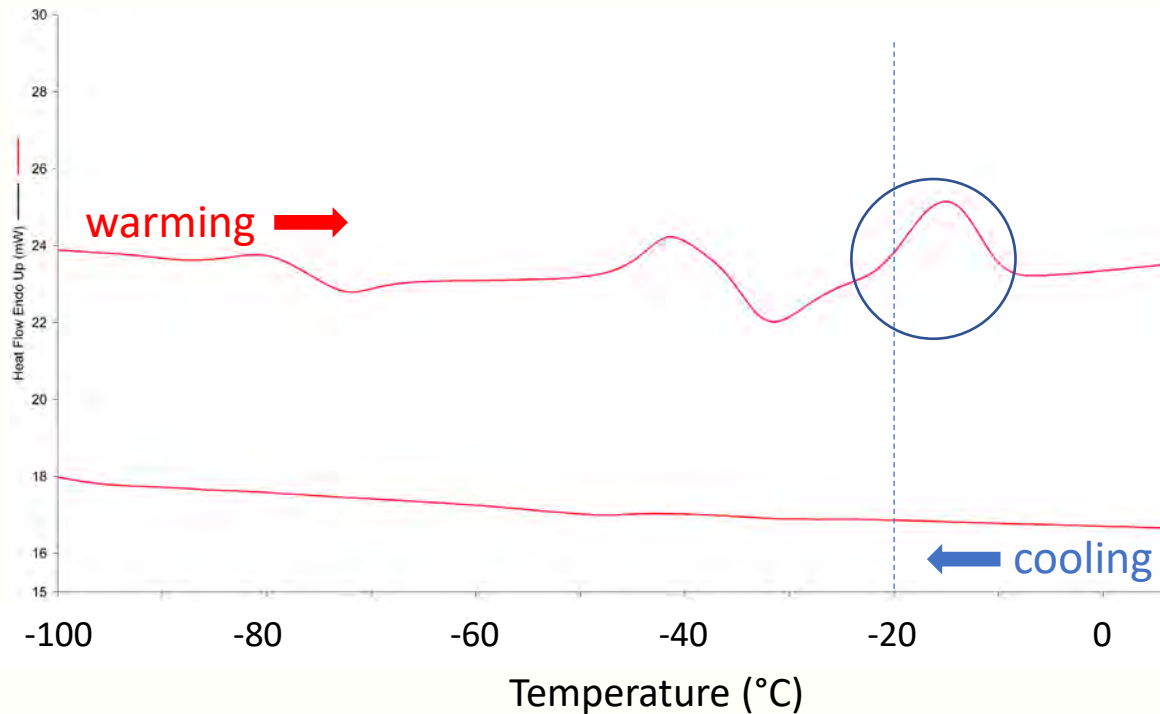
- Differential scanning calorimeter used to
 - Lower seed temperature to -150°C
 - Raise temperature from -150 to 50°C
- Thermal events (energy changes) during freezing and thawing recorded
- Output examined for
 - Major thermal events around -20°C
 - Temperatures where no energy changes occur
 - possible alternate storage temperatures



Example output

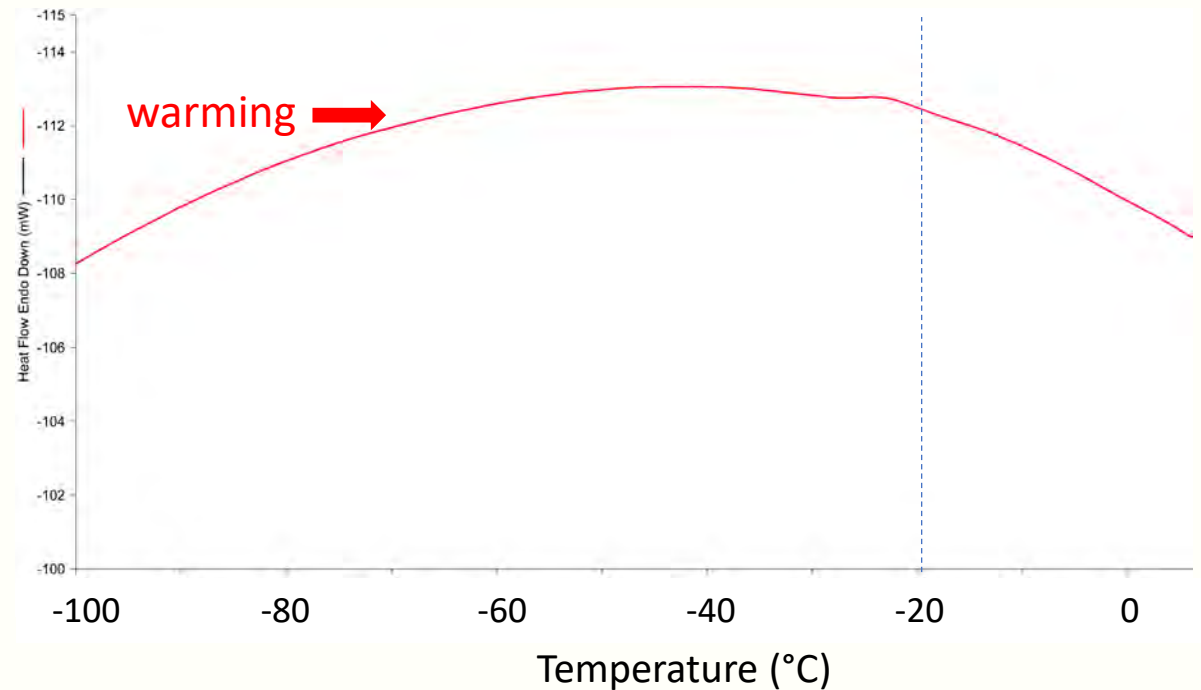
- *Rhodamnia maideniana*

- Rainforest tree
- short-lived in storage at -20°C



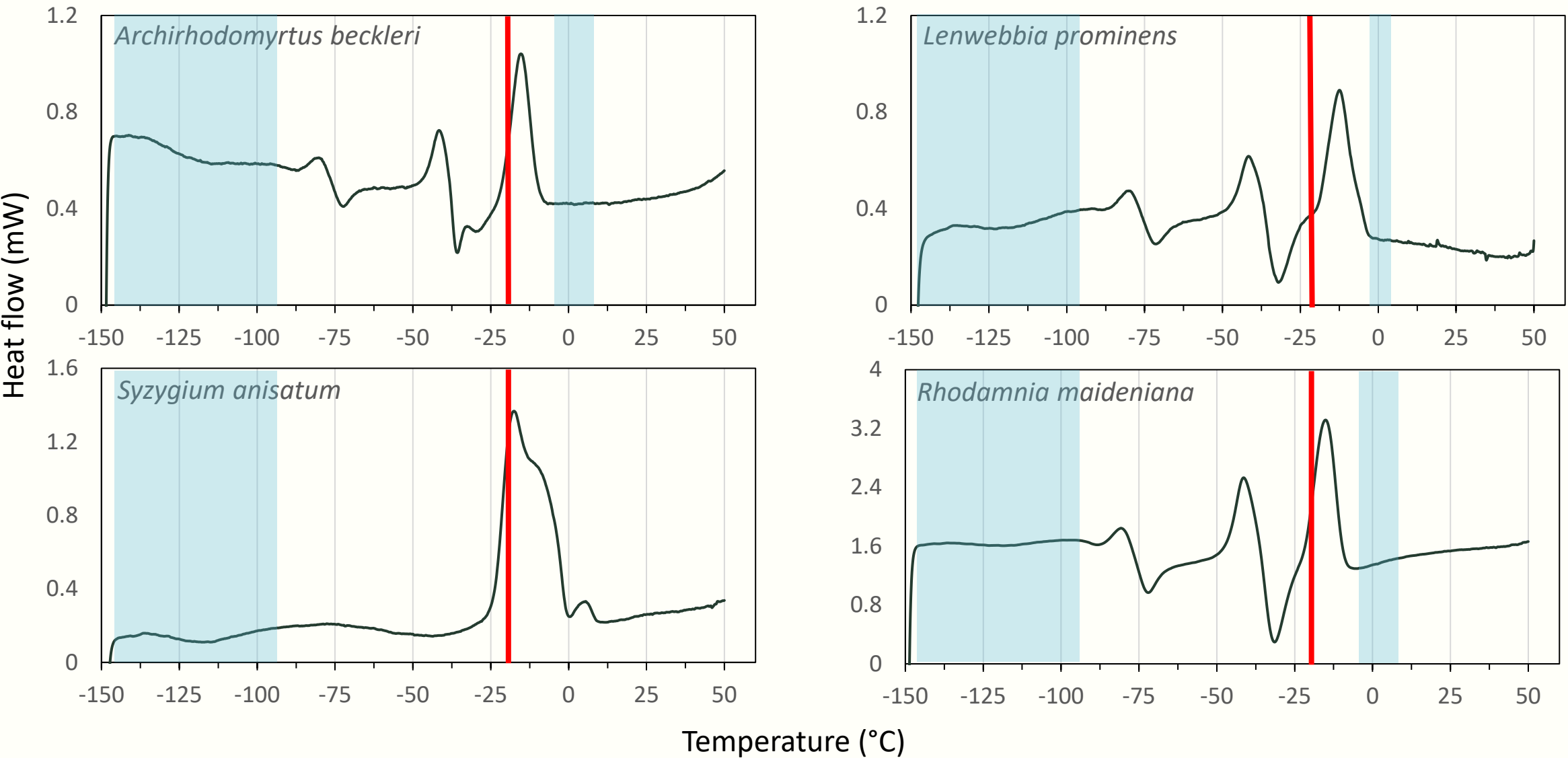
- *Syncarpia glomulifera*

- Rainforest/WSF tree
- long-lived in storage at -20°C



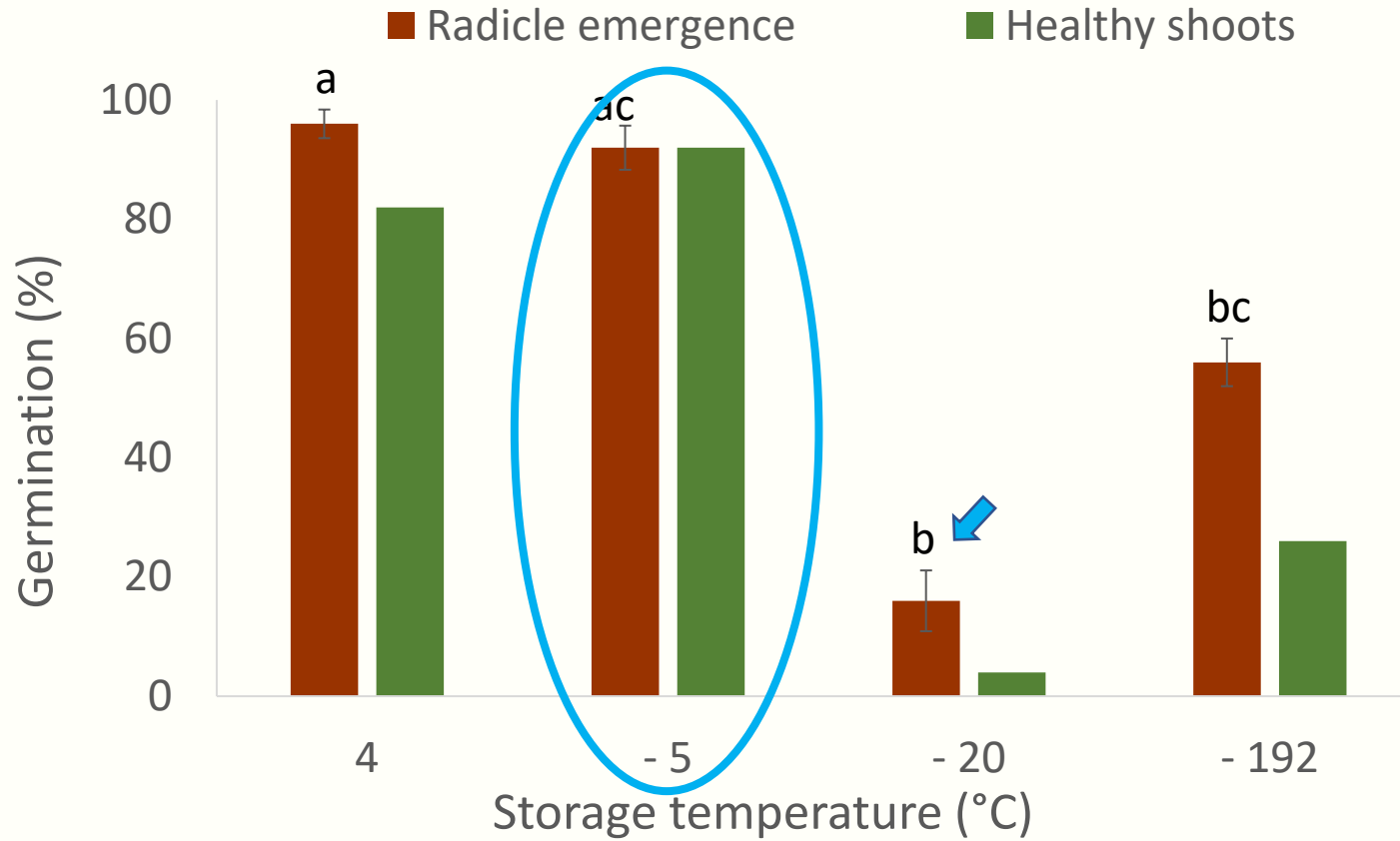


Short-lived species had a ‘melt’ reaction around -20°C

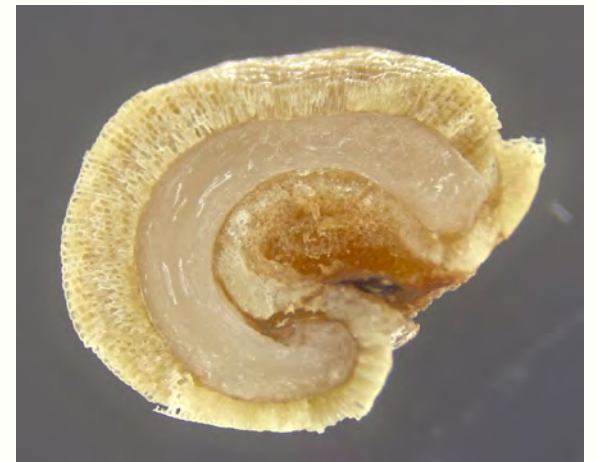


Storage experiments validated thermal analysis

Rhodamnia maideniana - Moisture content 3%, stored 12 months

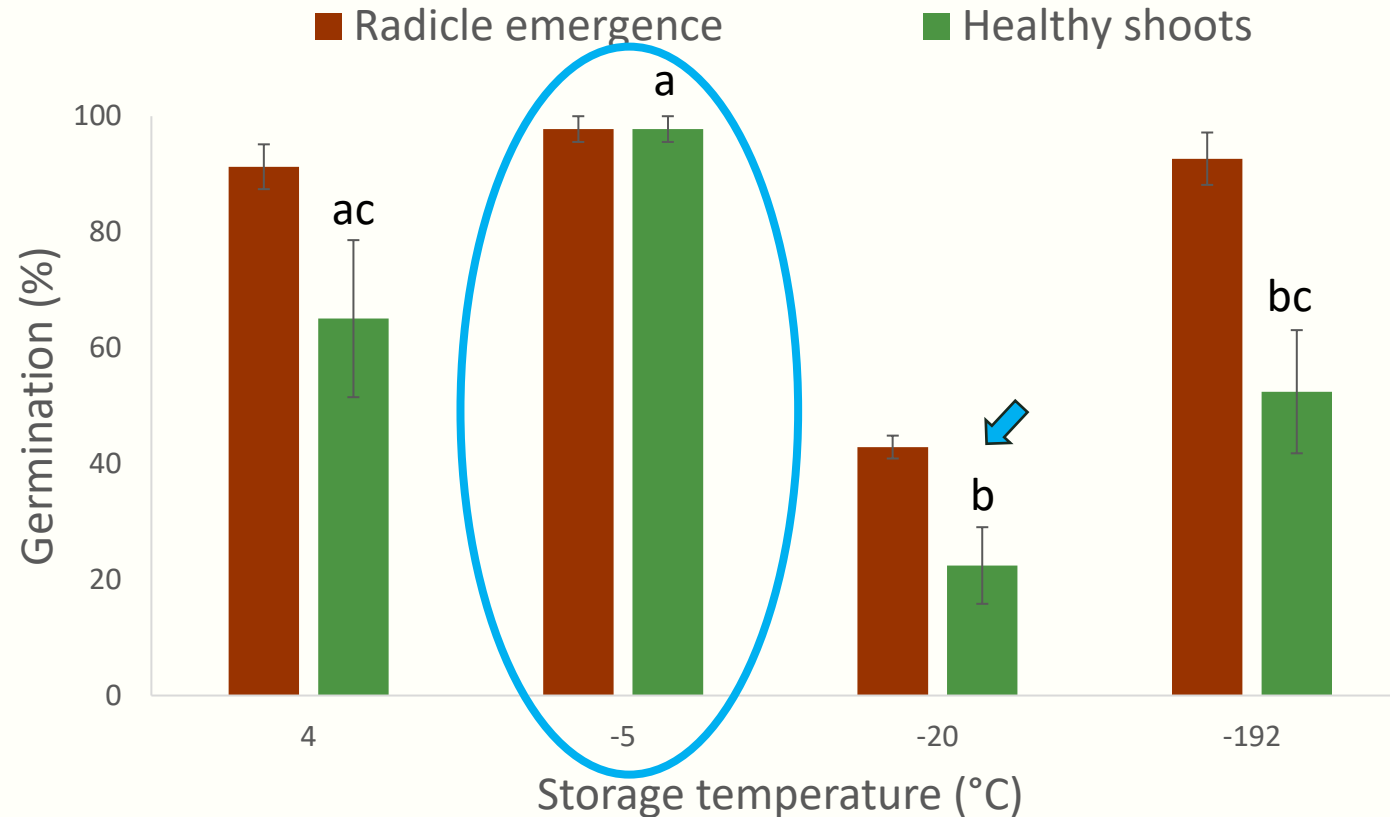


Best stored at 4 or -5°C



Storage experiments validated thermal analysis

Archirhodomirtus beckleri - Moisture content 8%; stored 4 months*

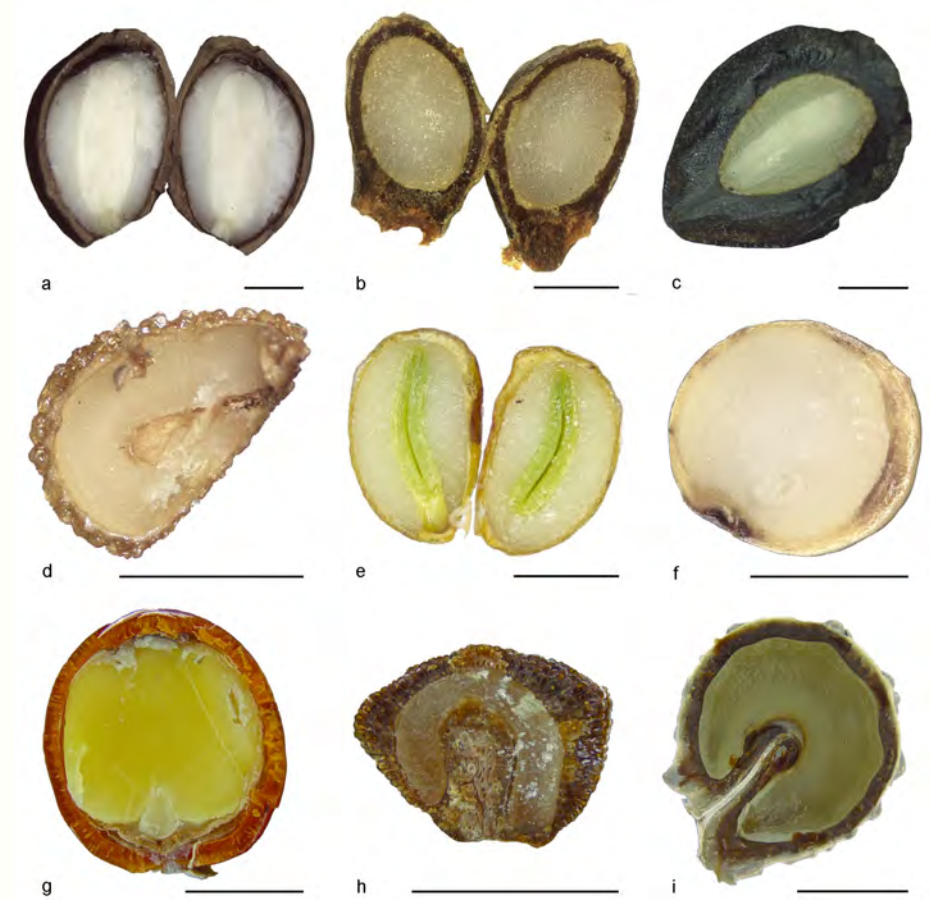


Best stored at -5°C with 8% moisture content



So can rainforest seeds be banked?

- Many can
- Long term storage requires research on best moisture content and storage temperature
- Short term storage can be accomplished by drying in an air-conditioned room and storing in the fridge



Storable rainforest seeds
(scale bar = 2mm)



**BOTANIC
GARDENS
OF SYDNEY**

Thank You

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Royal Botanic Garden Sydney | Australian Botanic Garden Mount Annan | Blue Mountains Botanic Garden Mount Tomah | The Domain Sydney | Australian Institute of Botanical Science

