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Optimizing germination of Asteraceae annuals from the winter-rainfall region of South Africa: A review

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Content

- Value of annuals
- Asteraceae-family
- Propagation-challenges
- Winter-rainfall
- Life-forms of the Cape Flora
- Fruit polymorphism
- Temperature, light & other pre-germination treatments
- Way forward



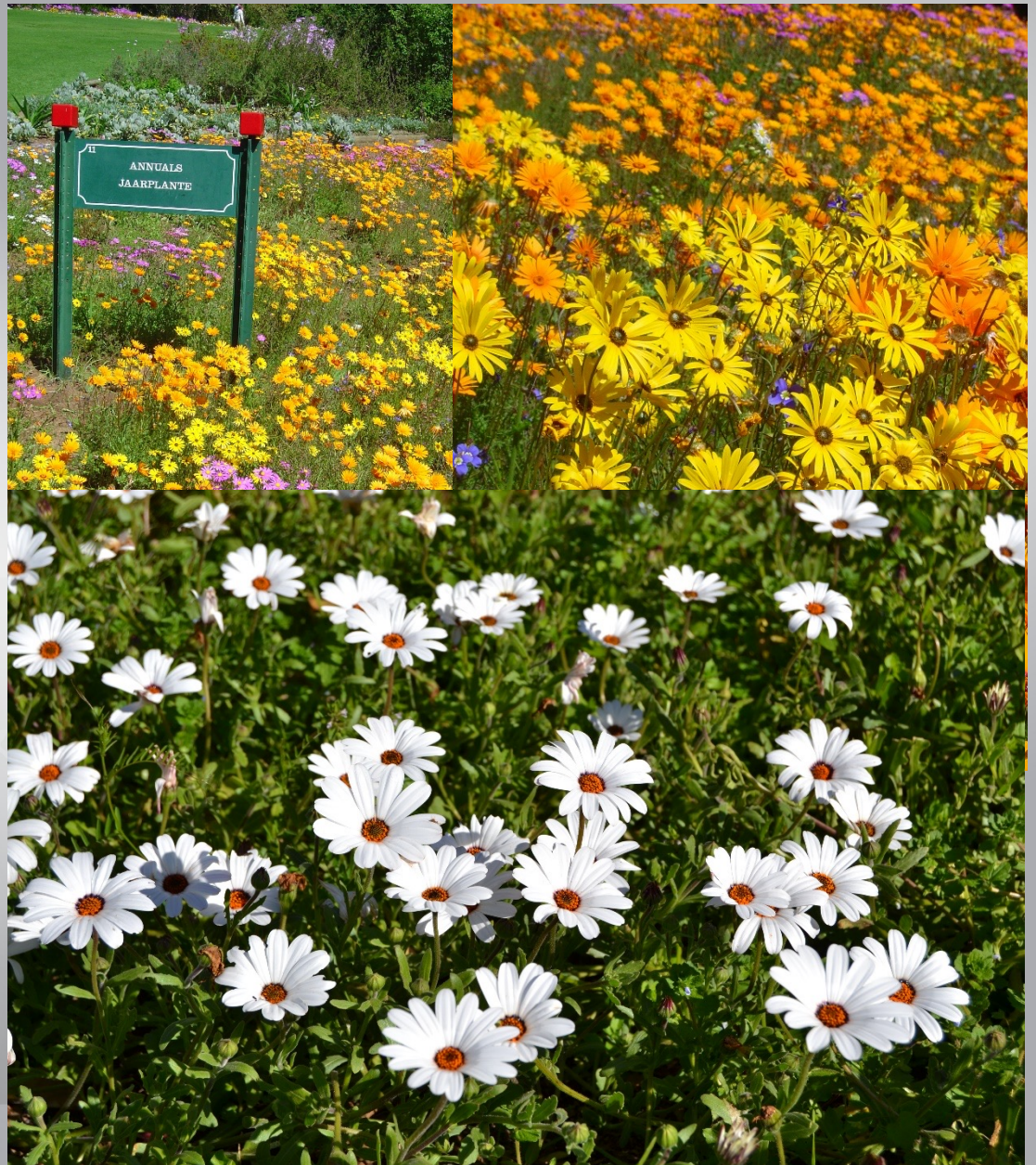
Value of annuals

- Garden
ornamentals
- Bring wildlife to the
garden
- Medicine



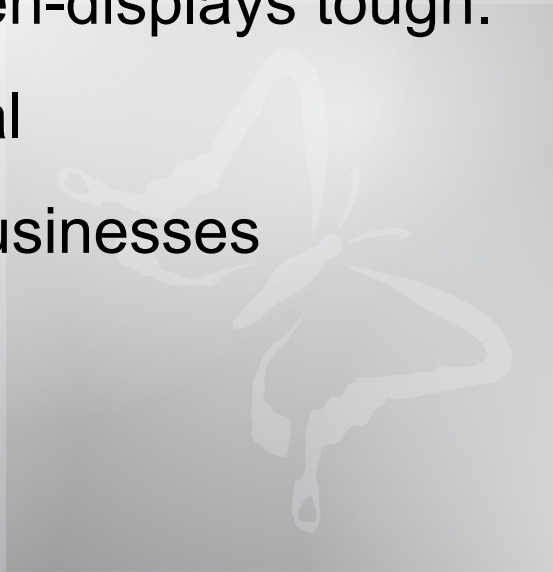
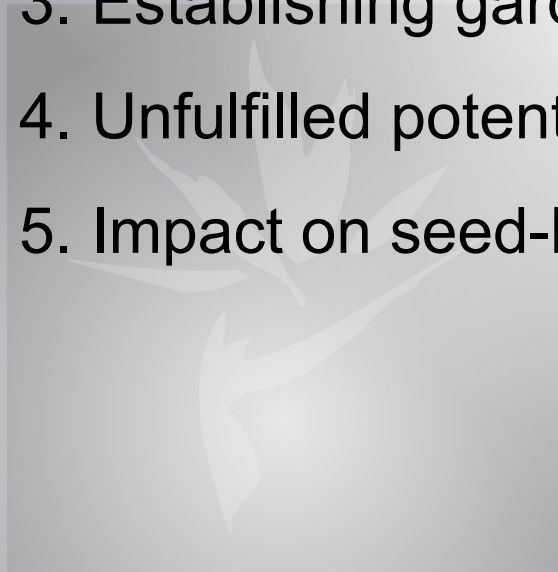
Annuals Living-collection at Kirstenbosch NBG

- Earliest collections dates back to year Garden started in 1913
- Aizoaceae, Brassicaceae, Scrophulariaceae & Asteraceae
- Informal tenant with only dedicated display-section from late 1970's
- High impact display-collection
- Used to draw visitors to less frequented areas
- Huge drawcard by several horticulturists all over Garden
- Lots of free publicity in good years- West Coast/ Namaqualand to visitors
- Display-section, Wheatfields/Koringlande, lay fallow in summer before 1994
- Moved towards summer-annuals after 1994



Challenges: Propagation winter-annuals

1. Poor germination of fresh, wild-collected seed.
2. Limiting species in cultivation.
3. Establishing garden-displays tough.
4. Unfulfilled potential
5. Impact on seed-businesses



Seed dormancy

- Dispersal in summer restrict germination
- Impact embryo, seed coat or seed covering
- Asteraceae-species from Med-areas
- Limitation of species to horticulture
- Non-deep physiological dormancy
- Low growth potential of embryo/ inability of embryo to push through the pericarp

Asteraceae

- Large, widespread family
- > 21 400 species
- Large concentration in winter-rainfall region
- Major variation in growth form & general morphology
- Variations allow us to benefit from this extraordinary diversity

Winter-rainfall region

FYNBOS

Rich species diversity & endemism

Low number of annuals

Areas of strandveld/sand
fynbos/renosterveld

SUCCULENT-KAROO

Desert-like region in Western &
Northern Cape

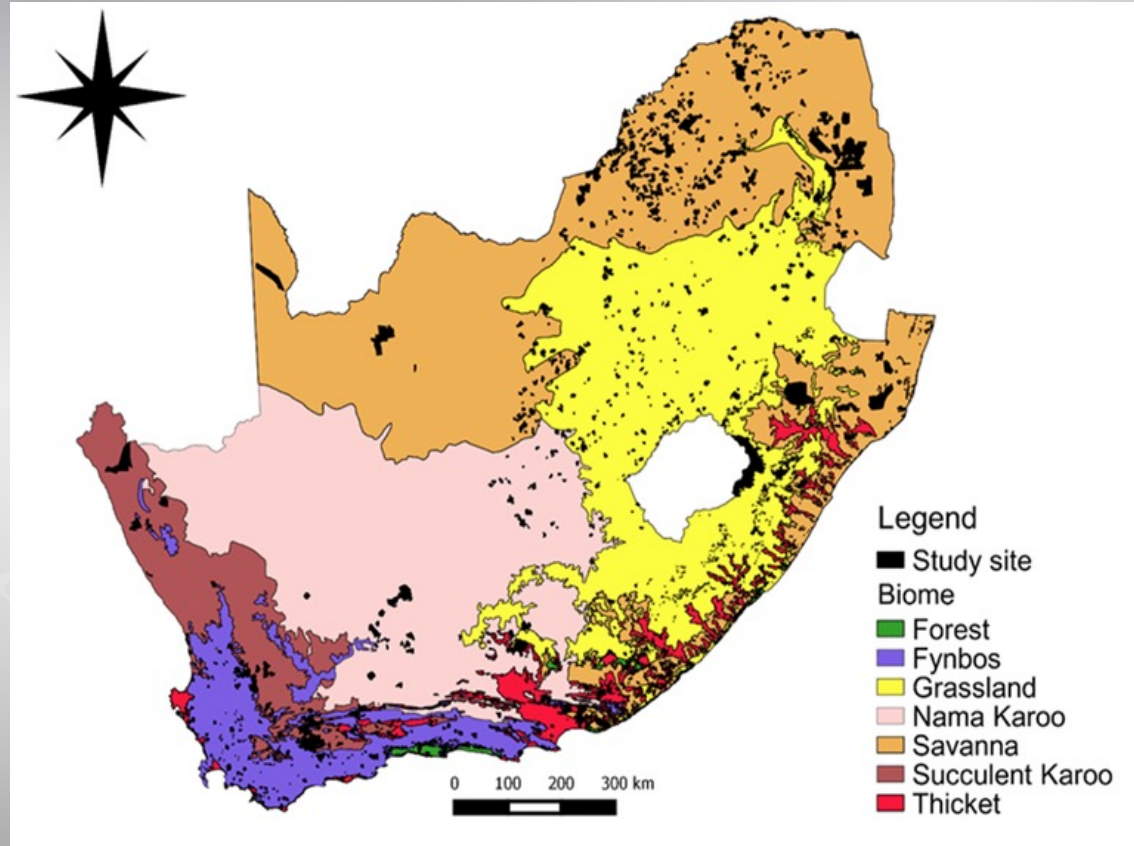
High species endemism

High number of annuals

MEDITERRANEAN CLIMATE

Mild, wet winters

Dry, hot summers



Life forms of the Cape Flora

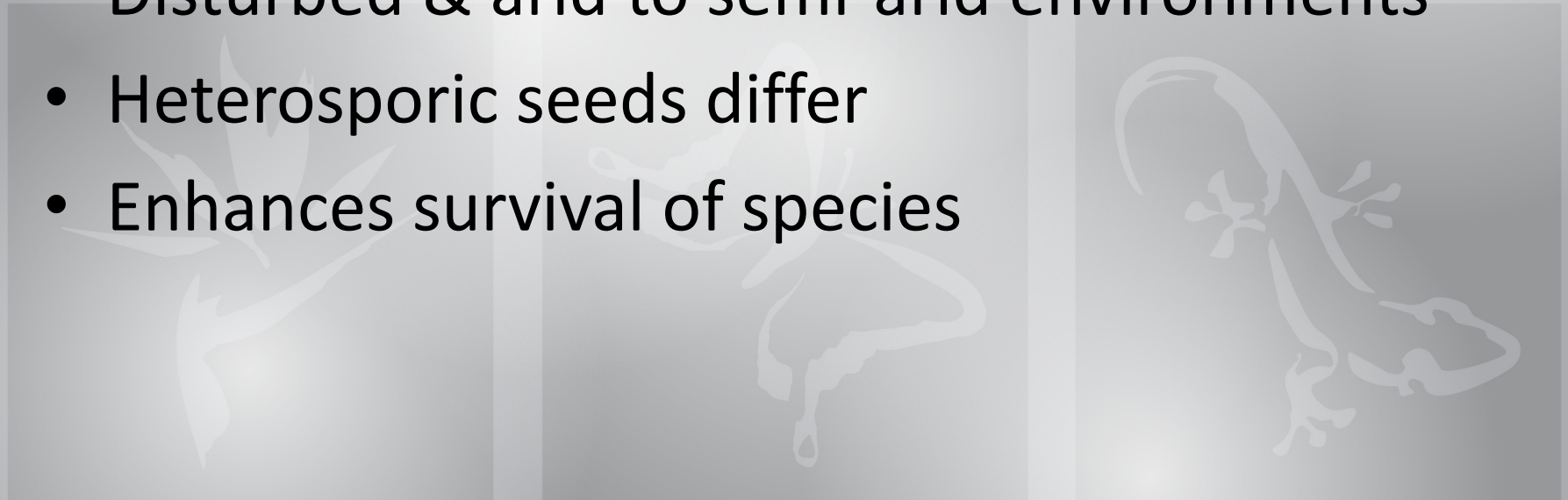
Life form	No. species (% of flora)
Trees	220 (2.3)
Shrubs and subshrubs	± 5 000 (54.0)
Perennials	1 035 (11.0)
Geophytes	1 635 (17.2)
Graminoids	795 (8.4)
Annuals	612 (6.5)
Other	80 (0.6)
TOTAL	9 383 (100)

Families with the highest number of annuals in the Cape flora.

Family	No. of species
Scrophulariaceae	167
Asteraceae	132
Brassicaceae	35
Poaceae	27
Cyperaceae	27
Aizoaceae	26
Fabaceae	23
Crassulaceae	23
Campanulaceae	21
Gentianaceae	17
Molluginaceae	16
TOTAL ANNUALS	612 (6.5% of flora)

Fruit polymorphism

- Typical to Asteraceae
- Annuals, weedy species
- Disturbed & arid to semi-arid environments
- Heterosporic seeds differ
- Enhances survival of species



(L) *Arctotis fastuosa*: black & brown diaspores
(R) *Dimorphotheca sinuata*: ray & disc diaspores



The roles of temperature, light & pre-germination treatments



Temperature

- Enhanced germination in winter
- Field temperature & field range overlap
- Mostly low optimum temperatures
- Asteraceae germinate over wide spectrum
- Different species stretched over time
- Fluctuations of the temperature range

Light

- Triggers germination along with temperature
- Wild species' seeds variable response
- Light needs differ according to temperature
- Often no light needed at low temperatures
- Diaspore-specific at temperatures

A summary of the light requirements, germination temperature and optimum germination percentage of several Asteraceae-annuals of Namaqualand (Visser, 1993).

Species	Light requirements	Germination temperature	Germination %
<i>Arctotis fastuosa</i> (brown)	Light	32°C	>10-20%
<i>Arctotis fastuosa</i> (black)	Light	32°C	>5-10%
<i>Arctotis gumbletonii</i>	Dark	17°C	>20-30%
<i>Dimorphotheca polyptera</i> (disc)	Dark	7°C	>60-70%
<i>Dimorphotheca polyptera</i> (ray)	Dark	12°C	>10-20%
<i>Foveolina albida</i>	Light	22°C	>5-10%
<i>Felicia australis</i>	Light	17°C	>40-50%
<i>Oncosiphon grandiflorum</i>	Light	27°C	>30-40%
<i>Osteospermum amplectens</i>	Dark	12°C	>30-40%
<i>Osteospermum hyoseroides</i>	Light	22/12°C	>10-20%
<i>Osteospermum pinnatum</i>	Light	7°C	>40-50%

Dimorphotheca sinuata diaspores: Germination-comparison

Disc diaspores

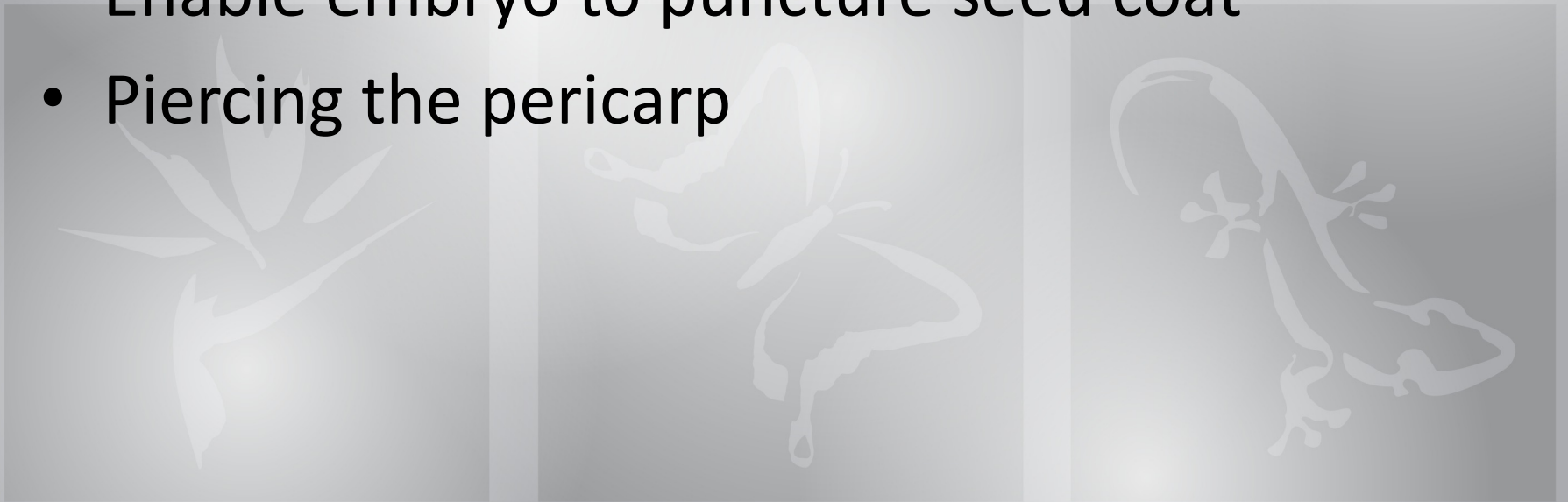
Temp (°C)	Light	Dark
7	88	83.5
12	88	85
17	95.5	90.5
22	79	92
27	68.5	64.5
32	32	5.5
22/12	73.5	84.5
27/17	57	76

Ray diaspores

Temp (°C)	Light	Dark
7	1.5	0.5
12	1	0.5
17	3	1.5
22	1.5	0.0
27	0	1.0
32	0	0.0
22/12	1.5	0.5
27/17	0	0.5

Scarification

- Seed coat often exerts restraint on the embryo
- Thrust needed via inhibition and growth
- Enable embryo to puncture seed coat
- Piercing the pericarp



Mean germination percentages of ten Strandveld Succulent Karoo plant species, after various dormancy-breaking treatments. Plant type, temperature and light condition at which germination was conducted, and the number of weeks that seeds were stored, are indicated between brackets (De Villiers, *et al.*, 2002).

		Species		
Treatment	Senecio arenarius 17°C (L); 24	Ursinia speciosa (white) , 17°C (L); 19	Dimorphotheca pluvialis (Disc): 17°C (L); 25	Dimorphotheca pluvialis (Ray): 17°C (L), 21
Control	66.4	9.2	86.4	19.2
Scarify	81.6~	0.0#	85.2	22.4
Scarify + Leaching	80.4~	0.0#	87.2	10.8#
Scarify (sandpaper)	*	*	*	*
Scarify (sandpaper) + Leaching	*	*	*	*

* : Treatment not used for this species

~ : Mean germination percentage significantly higher than that of the control treatment ($P \leq 0.05$)

: Mean germination percentage Significantly lower than that of the control treatment ($P \leq 0.05$)

More scarification-treatments

Treatment	<i>Dimorphotheca sinuata</i>	<i>Leysera tenella</i>	<i>Foveolina tenella</i>
Untreated	2.50%	11%	21%
Scarification	81.50%		37%
Leaching	1%	54%	18%

After-ripening

- Storage of seed at various temperatures
- Prevalent in Asteraceae
- Strong dormancy; alleviated slowly
- Expand germination-windows
- Improved & faster germination
- Differ according to species

Mean germination percentages at 17°C in the light of 27 Strandveld Succulent Karoo plant species, stored for different periods

Species	Fresh seeds air-dried for 2 weeks at 20°C	Seeds stored dry at 20°C for 6 weeks	Seeds stored dry at 20°C for 28 weeks	Significance level (P≤0.05)
Group 1 - Germination percentage increased significantly after 28 weeks of storage				
Dimorphotheca pluvialis (disc)	0.0a	0.4a	86.4a	0.0000
Dimorphotheca pluvialis (ray)	0.0a	0.0a	64.5b	0.0000
Senecio arenarius	0.0a	0.0a	50.5b	0.0000
Ursinia anthemoides (black)	0.0a	0.0a	5.0b	0.0001
Ursinia anthemoides (grey)	0.0a	0.0a	33.5b	0.0000
Ursinia anthemoides (white)	0.0a	0.0a	3.5b	0.0001
Ursinia speciosa (black)	0.0a	0.0a	10.0b	0.0000
Ursinia speciosa (white)	0.4a	0.4a	36.5	0.0000

Towards realizing germination optimization



Comparison

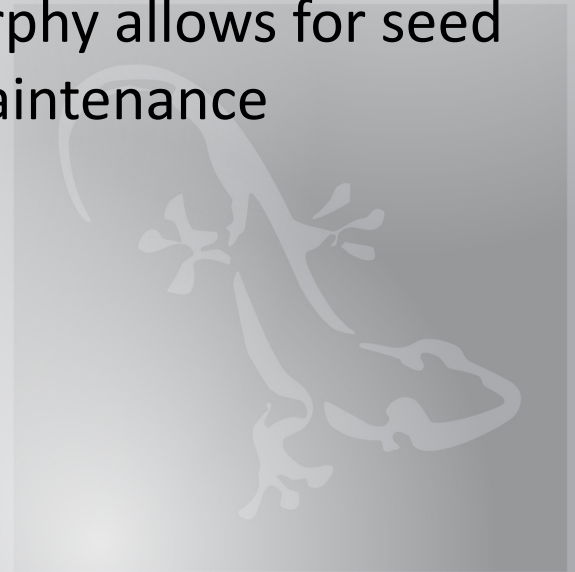
Disadvantages

- Poor germination
- Dormancy-alleviation take long time



Advantages

- Some species need one season of after-ripening
- Polymorphy allows for seed bank maintenance



Way forward

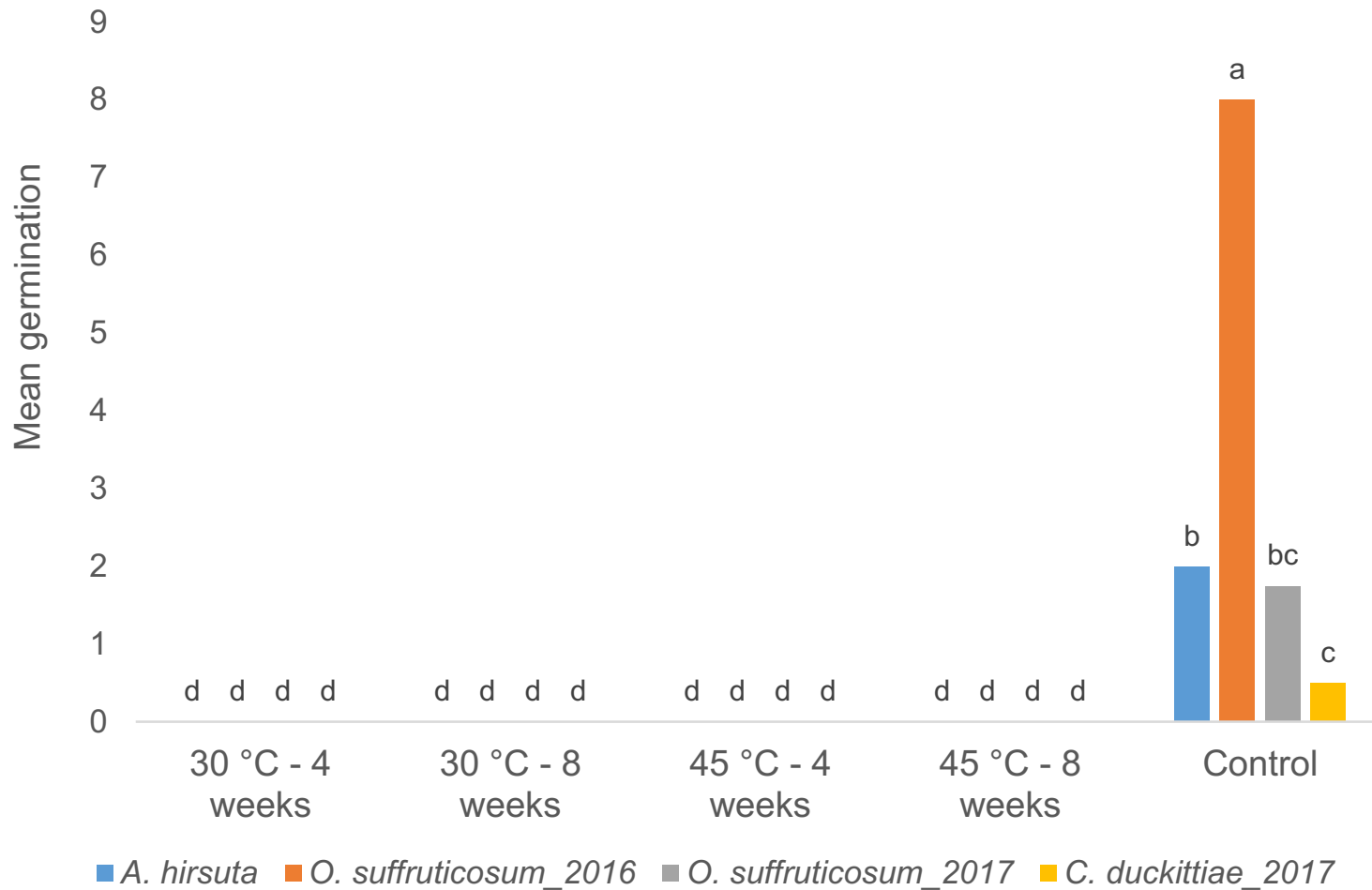
- Improved germination in first autumn
- Review existing seed-storage facilities
- Species specific treatments
- Factor in seed anatomy
- Use of combinational treatments
- Expand on existing after-ripening methods

After-ripening at higher temperature

Storage period	Storage temp (°C)	<i>Schoenia filifolia</i> subsp <i>filifolia</i>	<i>Rhodanthe</i> <i>chlorocephala</i>
3 months	15		> 90
3 months	25	> 85	> 90
3 months	30	> 85	> 90
3 months	40	> 85	> 90
3 months	55		> 90



Combined graph



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Thank you

