Seed bank characteristics of *Muehlenbeckia horrida ssp. abdita* from Lake Bryde

Penelope Fewson
WA Herbarium, **CALMScience** Division, Department of Conservation and Land Management, Locked Bag 104, Bentley Delivery Centre, Western Australia 6983.
14th June 2003

Abstract

Muehlenbeckia horrida ssp. abdita is a critically endangered plant belonging to the Polygonaceae family. Low numbers of viable seed were found in the seed bank on Lake Bryde at 7 different locations. A higher final germination percentage of plants are evident where dense aquatic plant matter was present. Viable seed is present throughout the lake and isn't isolated to one specific area of Lake Bryde. *M. horrida ssp. abdita* is dependent upon recruitment of individuals from the seed bank for future survival. Salinity and environmental conditions may further effect recruitment levels of plants.

Introduction

Accumulation of seeds in soil forms a seed bank and provides seed for subsequent germination (Mayer & Poljakoff-Mayber 1989). Some seeds germinate as soon as they are in a suitable environment. Other seeds are dormant and will not germinate, even if sown in a favourable place, until a specific environmental cue causes them to break dormancy. Germination firstly relies upon imbibition to trigger metabolic changes in the embryo to cause the radicle to emerge through the seed coat.

Temperature and moisture factors are essential for optimal germination of *M. horrida ssp. abdita*. Fruit fulfil an ecological role in seed dispersal (Mayer & Poljakoff-Mayber 1989). Fruits of *M. horrida ssp. abdita* are designed to float and protect seeds from extremes of temperature. The fruits provide a dispersal method to other areas within a lake system.

Seeds may fail to germinate initially and enter secondary dormancy (Bewley & Black 1994). Seeds may germinate at a later stage in conditions to break dormancy. Environmental factors involving water, temperature, gases, light and biotic factors (Mayer & Poljakoff-Mayber 1989) can effect germination.

Lake Bryde is characterised by searing heat, hypersaline wet clays, waterlogged soils and flooding in wet years. Principal factors that affect species

zonation seem to be drainage/hydroperiod salt load, salt composition and temperature (UWA Centre for Land Rehabilitation 2001).

The soil seed bank is the most valuable resource for the recruitment of species in temperate Australian vegetation (Dixon and Meney 1994). *M. horrida ssp. abdita* depends upon recruitment levels within the soil seed bank to replace older, established plants.

Soil was collected from seven sites in Lake Bryde on the 30th April, 2002.

Table 1. 7 sites where soil seed bank samples were taken from Lake Bryde on 30/04/03.

SITE NO.	LOCATION	ALIVE/DEAD PLANTS	NO. OF REPLICATES
1	S Shore	Alive	4
2	S Middle Slope	Alive	4
3	S Middle Shore	Dead	4
4	Middle Low Point	Alive	4
5	W Middle Low Point	Dead	4
6	W Upper Slope	Dead	4
7	NNE Upper Shore	Alive	4

The hypothesis to be tested:

H_o: Viability of *M. horrida ssp. abdita* collected from 7 different soil sites at Lake Bryde is not the same.

Materials and Method

Materials

15mm by 15mm quadrats
Trowel
Collection bags
Soil sieves (Ranging from 1mm – 3.5mm)
Bowls
Water
Forceps
Light microscope
100mL of 0.75% agar solution
Petri Dishes (6 small)
50%ppm preservative treatment
Pippette
Laminar Flow Workstation
Temperature Cabinet – 16°C (alternating 12 hours light/darkness)
Scalpel
Sterile soil substratum (for germinants)
Plastic Containers

Method

The seed collected was sieved through large 3.5 mm sieves initially to remove clay lumps. Followed by secondary sieving through 1 mm sieves to remove fine sand particles. Fruits and seed were removed upon observation. Heavier clay lumps were immersed in water and the fruits floated to surface of water were collected.

Clay lumps were broken down to release seed from clay soil particles. Water was drained off and remaining sinking fruits were collected.

The seeds were excised from the fruits using a light microscope. The 65 seed collected from 7 sites was placed on 0.75% agar solution after settling to room temperature for 24 hours.

Results

The middle low point in the lake had the highest mean percentage of seed (266.67 seed/m^2) with endosperm present (Table 2).

Table 2. Mean number of seed found in soil taken from 7 different sites

Site	***1***	***2***	***3***	***4***	***5***	***6***	***7***
Mean No. Seed	13	0	10	24	3	7	8
Mean No. Seed/m^2	144.44	0	111.11	266.67	33.33	77.78	88.89

The northeastern shore of the lake which is less saline than the southern side of Lake Bryde, has the highest germination percentage (75 %) of all sites sampled (Figure 1). A higher germination percentage is evident where soils are loamy, soil substratum levels are higher and where a dense cover of aquatic plant matter is present (Appendix C, p10).

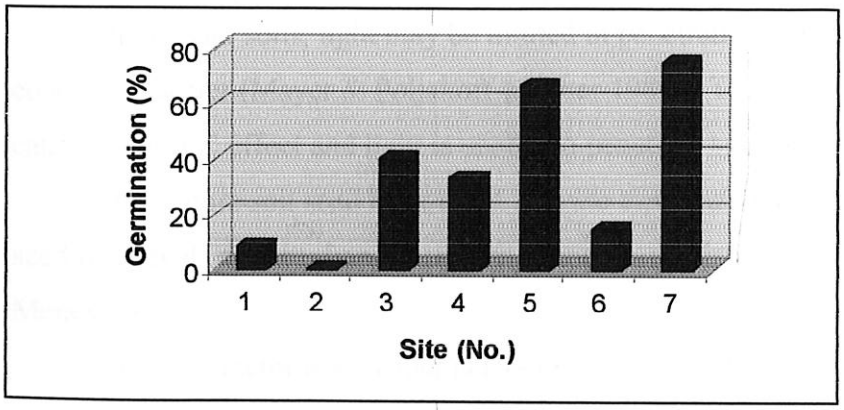

Figure 1. Final germination percentage after 22 days of soil seed bank samples at 3rd June, 2003.

In contrast, the southern shore and middle slope regions of Lake Bryde have 7.69 % and 0 % germination respectively (Figure 1). This corresponds directly to the observations of no cover of aquatic plant matter present, reduced leaf litter and low water points where saline waters can accumulate (Appendix C, p9).

M. horrida ssp. abdita seed is found in small numbers throughout Lake Bryde, except for southern mid-slope regions. Fruits float and come to rest in the topsoil when water recedes. Viable seed is found alongside dead adult plants.

Discussion

Low seed bank numbers can be a common feature of critically endangered flora. Reduced seed numbers found in soil seed bank samples could be due to summer rains in 2003. The sprouted seedlings found within soil seed bank samples and high numbers of recruitment of *M. horrida ssp. abdita* on Lake Bryde in May, 2003 is evidence of this.

Excision of seed from fruits causes damage and effects embryo germination. The leakage of solutes provides a food source for a variety of fungi. The dark purple leathery fruit coat of *M. horrida ssp. abdita* provides protection to the seed until conditions are suitable for germination.

Higher germination percentages of soil seed banks of plants are evident where microhabitat characteristics are favourable. 75 % germination of seeds occurs when aquatic plant matter can provide a moist environment, limiting drying soil temperature in summer months upon Lake Bryde. Soil temperature is also under the influence of quantity of water present in the soil as well as soil structure and texture (Mayer & Poljakoff-Mayber 1989). Fresh *M. horrida ssp. abdita* seed is confined to the upper layers of Lake Bryde and is prone to wide temperature fluctuations.

In heavier soils, light may be limited in penetration depth where soil is covered by water (Mayer & Poljakoff-Mayber 1989). The clay base of Lake Bryde causes a 'milky' effect and light is unable to penetrate as effectively in clear water.

The future soil seed bank of *M. horrida ssp. abdita* could be lowered due to seed life, levels of disturbances and the quantity and distribution of rainfall (Dixon & Meney 1994).

Another factor to consider is laboratory conditions as opposed to field conditions. Under field conditions, external factors other than water potential might affect water uptake and therefore germination (Mayer & Poljakoff-Mayber 1989).

The low amount of seed collected at Lake Bryde in the soil seed bank may be an underestimate of the quantitative level of *M. horrida ssp. abdita* seed present.

Conclusion

M. horrida ssp. abdita has a low quantity of seed present within the seed bank, typical of other critically endangered species present in Western Australian flora. Optimal temperature and moisture levels provide ideal germination conditions. Seasonal summer rains initiates germination upon Lake Bryde, given other internal and external dormancy factors is overcome.

Higher germination rates of seed are found in areas with a dense cover of aquatic plant matter. The aquatic matter plays a functional role in stabilising soil temperature for germination.

Viability of *M. horrida ssp. abdita* was highest in the northeastern part of the lake (Em38 ECe Value 101-2100 µS/cm), despite the greatest amount of seed found in the middle low point of the lake.

The structure of *M. horrida ssp. abdita* fruits allows seed to be present throughout Lake Bryde as water recedes. For the survival of *M. horrida ssp. abdita* in the future, successful recruitment of seed from the soil seed bank is essential.

References

Bewley, J.D. & Black, M. (1994). **Physiology of development and germination.** Plenum, New York. pp.284-290.

Dixon, K.W. & Meney, K.A. (1994). Seed Quality for Minesite Rehabilitation. National Workshop on Native Seed Biology for Revegetation (eds S. M. Bellairs & L.C. Bell). Kings Park and Botanic Gardens, Perth. pp.15-19.

Mayer, A.M. & Pojakoff-Mayber, A. (1989). **The germination of seeds.** Permagon, Great Britain, pp.49-222.

UWA Centre for Land Rehabilitation. (2001). **Proceedings of the salt lake work shop.** UWA, Perth, pp.4.

APPENDICES

APPENDIX A

Weight of 28 soil samples taken from 7 sites at Lake Bryde on 30th April, 2003

Site	Weight (g)	No. of Seed
1 Live Shore	105.379	0
	199.839	4
	286.905	8
	261.536	1
2 Live Mid Shore	186.507	0
	344.550	0
	395.510	0
	102.134	0
3 Dead Mid Shore	137.197	0
	131.308	4
	331.710	4
	162.286	2
4 Alive Mid Lake Low Point	71.475	8
	188.276	13
	52.418	2
	251.826	1
5 Dead Mid Lake Low Point	149.846	1
	198.323	1
	59.300	0
	310.499	1
6 Dead Upper Slope	276.502	3
	254.122	4
	328.212	0
	401.144	0
7 North/Eastern upper shore	131.137	6
	319.377	1
	348.626	1
	136.480	0

APPENDIX B

Seed bank germination experiment beginning on 12th May, 2003

Pre-treatment:

Replicate 1 (Site 1)	0.75 % agar.	50 % ppm treatment soaked for 1 hour
Replicate 2 (Site 3)	0.75 % agar.	50 % ppm treatment soaked for 1 hour
Replicate 3 (Site 4)	0.75 % agar.	50 % ppm treatment soaked for 1 hour
Replicate 4 (Site 5)	0.75 % agar.	50 % ppm treatment soaked for 1 hour
Replicate 5 (Site 6)	0.75 % agar.	50 % ppm treatment soaked for 1 hour
Replicate 6 (Site 7)	0.75 % agar.	50 % ppm treatment soaked for 1 hour

Treatment 1							
Replicate		**1**	**2**	**3**	**4**	**5**	**6**
No. of Seeds		13	10	24	3	7	8
Date	**Days**	**No. of germinants**					
12/05/03	0	0	3	8	2	1	6
13/05/03	1	1	1	0	0	0	0
03/06/03	22	0	0	0	0	0	0
Final Germination (%)		7.69	40	33	66.67	14.29	75

APPENDIX C

Site	Replicate	Observations	Seed No.
1	1	Insects present (Homoptera). High % leaf litter. Immature flowers of *M. horrida ssp. abdita*.	0
	2	Insects present (Spider). Clumped clay soil. Small % leaf litter. Empty, non-viable *M. horrida ssp. abdita* seed that appears to be eaten out. Most fruits contain no seed.	4
	3	Insects present (Homoptera)Small % leaf litter. Clumped clay soil.	8
	4	Insects present (Homoptera). Medium % leaf litter.	1
2	1	Clumped clay/sand soil. Negligible % leaf litter. Aquatic plant mat light-moderate cover. Few empty fruits (<10).	0
	2	Clumped clay/sand soil. Negligible % leaf litter. Few empty fruits (<10).	0
	3	Clay lumped soil. Negligible % leaf litter. Light covering of aquatic plant matter. Insects present (1 ant). 25 empty fruits.	0
	4	Clay/Sand soil. Negligible % leaf litter. Light covering of aquatic matter. Few fruits (<10).	0
3	1	Clay lump/sand mix. Insects present (Homoptera). Negligible % leaf litter. Moderate covering of aquatic matter. Few empty flat *M. horrida ssp. abdita* fruits.	0
	2	Clay lump/sand mix. Insects present. Negligible % leaf litter. Moderate covering of aquatic matter.	4
	3	Clay lump/sand mix. Insects present. Moderate covering of aquatic matter. Negligible % leaf litter. Dead pieces of *M. horrida ssp. abdita*. 1 sprouted seed.	4
	4	Sand/clay lump mix. Insects and molluscs present. Moderate covering of aquatic matter. Negligible % leaf litter. Dead pieces of *M. horrida ssp.abdita.*	2
4	1	Clay/sand mix. Insects and molluscs present (Homoptera) Low % leaf litter. High % of aquatic matter. 7 sprouted seedlings. Dead pieces of *M. horrida ssp. abdita.*	8
	2	Sand/clay mix. Insect larvae present. Low % aquatic matter. Negligible % leaf litter.	13
	3	Sand/clay lump mix. Medium % of aquatic matter. Low % leaf litter. 1 sprouted seedling.	2
	4	Sand/clay mix. Medium % aquatic matter. Low % leaf litter.	1
5	1	Sand/clay lump mix. Insects present. High % of aquatic plant material. Low % leaf litter. 10 Flat *M. horrida ssp abdita* fruits with no seed.	1
	2	Sand/clay lump mix. Insects present (Homoptera). Medium % aquatic matter. Low % leaf litter.	1
	3	Sand/clay mix. Low % leaf litter. Medium % of aquatic matter.	0
	4	Sand/clay mix. Medium % aquatic matter. Low % leaf litter.	1
6	1	Sand/clay lump mix. Low % aquatic matter. Low % leaf litter. Broken pieces of *M. horrida ssp. abdita.*	3
	2	Clay lump/sand mix. Negligible % leaf litter. Dead pieces of *M. horrida ssp. abdita.*	4
	3	Sand/clay lump mix. Low aquatic matter %. Negligible leaf litter %. Molluscs present. Moderate amount of fruit (25) with non-viable seed.	0
	4	Sand/clay lump mix. Low % aquatic matter. Low % leaf litter. Dead pieces of *M. horrida ssp. abdita. Tecticornia verrucosa* seed pods present. Moderate amount of fruit (40) with non-viable seed.	0

Site	Replicate	Observations	Seed No.
7	1	Loam/clay lump mix. High % covering of aquatic matter. Moderate leaf litter %. Molluscs present. Seed is less water stained than sites 1-6.	6
	2	Loam/clay lump mix. Moderate leaf litter %. High % aquatic matter. Dead pieces of *M. horrida ssp. abdita.* 1 seedling present.	1
	3	Loam/clay lump mix. Moderate % leaf litter. High % aquatic matter. Molluscs present. Dead pieces of *M. horrida ssp. abdita.*	1
	4	Loam/clay lump mix. Insects and molluscs present. Moderate leaf litter %. Low % aquatic cover.	0