



## *Borya mirabilis* Grampians Pincushion-lily

### Taxonomy

*Borya mirabilis* Churchill

### Current conservation status

Listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999*.

Listed as threatened under the *Flora and Fauna Guarantee Act 1988*.

Categorised as Endangered in the 2014 Advisory list of rare or threatened flora (DEPI 2014).

### Proposed conservation status

Critically Endangered in Australia

Criteria B1ab(iii,v)+2ab(iii,v)

### Species Information

#### Description and Life History

Plants tufted, stems erect or ascending to 15 cm high. Leaves linear, firm but pliant, clustered toward stem apices, 10-16(-22) mm long, c. 0.5 mm wide, base tapering gradually from the sheath which is pale brownish with fine cottony hairs on upper margin, lamina glabrous, apex pungent. Scapes 3-7 cm long, simple; head ovoid, 6-10 mm long, 4-8 mm wide, 4-12-flowered with 3-15 linear, pointed bracts to 13 mm long; flowers white, perianth tube c. 6 mm long; lobes linear, c. 6 mm long. Fruits and seeds are unknown. Flowers Sep.- Oct. Ovules are produced but have not been observed to produce viable seeds. (VicFlora, 2018)

The taxon is not known to have ever set seed in Victoria, although species of this genus elsewhere in Australia (notably NT and WA) apparently set seed freely. Any reproduction is vegetative and clonal, and adjoining the existing mat of stems. The natural occurrence has not grown much, if at all, since it was first discovered.

#### Generation Length

The generation length of *Borya mirabilis* is projected to be 100 years. Since European settlement, the taxon has not been known to set seed and no germinants have been noted. Hence 100 years is a low estimate for generation time.

#### Distribution

A highly restricted Victorian endemic. The taxon's natural occurrence is restricted to a few square metres on a single rock ledge in the northern Grampians (Mackeys Peak). Another population has been established in the Difficult Range. Despite searches, it is not known elsewhere.

#### Habitat

The taxon occurs on sandstone ledges, prone to desiccation over summer and somewhat moist over winter. It is naturally somewhat protected from fire. It is known as a "resurrection" plant, in that it loses water from the foliage and can look dry and dead, but the foliage has the capacity to rehydrate on wetting.

## Threats

*Borya mirabilis* has only ever been known from a single wild population. The original wild and translocated populations face a variety of threats.

Disturbance to plants and their habitat is a major threat. Although the site is naturally prone to erosion due to the steep slope and sandy soil (Coates et al. 2002), this has been exacerbated in recent years by prolonged drought and occasional heavy rainfall. Additionally, the 2006 wildfire decreased vegetation cover which also increased erosion. Accelerated erosion of soil due to fire and drought is a significant threat to the survival of *B. mirabilis*, and in the past has been so severe as to leave the plants on pedestals of soil (Coates et al. 2002). Soil disturbance is also likely to limit the opportunity for vegetative reproduction, which is the main form of reproduction for this species. Digging by rabbits and echidnas and foraging activities of wallabies also contribute to soil disturbance and erosion. There is the potential for trampling by bushwalkers inadvertently straying onto the site, and also the risk of illegal collection by naturalists visiting the site eager to see this rare plant.

The plant pathogen *Phytophthora cinnamomi* is present in the vicinity of the wild population, affecting heathland species such as bush-peas (family Fabaceae) and *Correa* species (Reiter et al. 2004). *B. mirabilis* is a resurrection species and naturally displays many of the symptoms caused by *P. cinnamomi* (e.g. yellow leaves during desiccation) which makes visual detection of the pathogen difficult. Reiter (2002) isolated *P. cinnamomi* from a soil sample taken from the base of an unhealthy *B. mirabilis* plant and found that it is susceptible to infection by the pathogen, which causes chlorosis, browning, reduced vigour and reduced biomass (Reiter et al. 2004). There are a number of dead shrubs at the original site, but it is unclear as to whether their death is due to *P. cinnamomi*, drought and/or natural senescence. Many native vegetation communities undergo a change in lower strata structure, species composition and a decrease in canopy cover as a result of infection by *P. cinnamomi* (Weste et al. 2002). This loss of tree, shrub and ground cover over time would further exacerbate soil moisture loss and erosion at the site.

The population lacks genetic variability and fails to set seed, as pollen viability is low, and those pollen grains that do germinate produce pollen tubes that grow so slowly that effective fertilisation does not occur (Coates et al. 2002). Failure (or extremely low rates of success) to reproduce sexually is probably due to the self-incapability between plants of the same genotype. A significant number of flowers appears to be malformed, with shortened stigmas, four petals instead of six and fused anthers. *B. mirabilis* has about three times the number of chromosomes of its closest relatives, and it is possible that this apparent chromosome abnormality is causing flower malformations resulting in extremely low fertility (N. Reiter RMIT University, pers. comm.). Its small size and single occurrence also render the species particularly vulnerable to extinction due to stochastic events. The single natural and the new managed occurrences are so small that a single goat or wallaby could extinguish each by physical damage. Resurrection plants also tend to be poor competitors, growing on shallow soils where deeper-rooted, more vigorous species are unable to establish.

The response of *B. mirabilis* to fire is unclear, although fire is thought to threaten its survival (Churchill 1987). A bushfire in the Grampians in January 2006 severely burnt all *B. mirabilis* plants at the Wonderland site (though the translocated population was not burnt). Plants have shown signs of recovery since, with 50% of the plants re-sprouting within a few months of the fire. However recovery has been slowed by a reduction in shade and increased soil drying as a result of the fire, exacerbated by drought conditions, and about one-half of the ramets remained in a desiccated state, as of 2009. As the vegetation regenerates the site is becoming more shaded and retains more moisture, and it is likely that most plants will recover. The main issue seems to be related to increased risk of erosion due to loss of vegetation and leaf litter immediately after fire.

The taxon has the ability to tolerate desiccation over summer and rehydrate after the onset of autumn rains. However, prolonged drought conditions and increased exposure and drying of the site following summer bushfires seem to have contributed to reduced vigour of plants. Leaf shedding and a gradual decline in the ability of some plants to produce new growth or resurrect fully from a desiccated state have been observed during monitoring. Some Western Australian *Borya* species are known to reduce the impact of prolonged drying by shedding leaves during periods of stress (Churchill 1987), but it is not clear if *B. mirabilis* has this ability. Basal resprouting is observed mostly in plants growing beneath shrubs and in crevices between boulders, in deeper soils where plants are better protected from disturbance and moisture loss. Reduction of rainfall and long-term drying predicted as a result of climate change may be a major long-term threat.

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In general, resurrection plants such as this may be unable to recover from a quiescent state that extends beyond a few years, after which time a proportion of cells fail to regenerate, physiological processes critical to revival are disrupted, and ultimately the plant dies (Gaff and Churchill 1976).

### IUCN Criteria

Criterion A. Population size reduction. Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	Critically Endangered	Endangered	Vulnerable
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3, A4	≥ 80%	≥ 50%	≥ 30%
<p>A1 Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.</p> <p>A2 Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible.</p> <p>A3 Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [(a) cannot be used for A3]</p> <p>A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.</p>			
<p>based on any of the following:</p> <ul style="list-style-type: none"> <li>(a) direct observation [except A3]</li> <li>(b) an index of abundance appropriate to the taxon</li> <li>(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat</li> <li>(d) actual or potential levels of exploitation</li> <li>(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites</li> </ul>			

### Evidence:

#### Eligible under Criterion A3 as Vulnerable

The population reduction over the next 100 years is projected to be 0 to 30%, based on (c) above.

The plant is at risk from the extremely small population area and numbers. Fires, both bushfires and planned burns, are an ongoing threat. Physical disturbance is a risk at both sites, since resurrection plants are extraordinarily brittle when desiccated.

The taxon has only ever been known from a single wild population, so it is not possible to determine if there has been any historic decline in distribution and/or abundance.

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Criterion B. Geographic range in the form of either B1 (extent of occurrence) and/or B2 (area of occupancy)			
	Critically Endangered Very restricted	Endangered Restricted	Vulnerable Limited
B1. Extent of occurrence (EOO)	< 100 km <sup>2</sup>	< 5,000 km <sup>2</sup>	< 20,000 km <sup>2</sup>
B2. Area of occupancy (AOO)	< 10 km <sup>2</sup>	< 500 km <sup>2</sup>	< 2,000 km <sup>2</sup>
AND at least 2 of the following 3 conditions:			
(a) Severely fragmented OR Number of locations	= 1	≤ 5	≤ 10
(b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			

### Evidence:

#### Eligible under Criterion B1 as Critically Endangered

The Extent of Occurrence (EoO) across the taxon's range is estimated to be 4 km<sup>2</sup>, based on accepted, post-1970 records from the Victorian Biodiversity Atlas (VBA).

It is inferred to have 1 location, as both stands are equally at risk from fires and physical disturbance. It has a continuing decline in (iii) and (v) above, based on the impacts of the identified threats.

#### Eligible under Criterion B2 as Critically Endangered

The Area of Occupancy (AoO) across the taxon's range is estimated to be 4 km<sup>2</sup>, based on 2 x 2 km grids derived from accepted, post-1970 records in the VBA. As above, it has 1 location and has a continuing decline in (iii) and (v) above.

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Criterion C. Small Population size and decline		Critically Endangered	Endangered	Vulnerable
Number of mature individuals		< 250	< 2,500	< 10,000
AND at least one of C1 or C2				
C1	An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future):	25% in 3 years or 1 generation (whichever is longer)	20% in 5 years or 2 generations (whichever is longer)	10% in 10 years or 3 generations (whichever is longer)
C2	An observed, estimated, projected or inferred continuing decline AND least 1 of the following 3 conditions:			
(a)	(i) Number of mature individuals in each subpopulation	≤ 50	≤ 250	≤ 1,000
	(ii) % of mature individuals in one subpopulation =	90 – 100%	95 – 100%	100%
(b)	Extreme fluctuations in the number of mature individuals			

### Evidence:

#### Ineligible under Criterion C

It is suspected that there are 1 to 15 (midpoint 8) mature individuals, but other thresholds under this criterion have not been met.

This species is strongly clonal and so rare that excavation to determine the number of individuals cannot be justified.

Criterion D. Very small or restricted populations		Critically Endangered	Endangered	Vulnerable
Number of mature individuals (observed or estimated)		< 50	< 250	< 1,000
D2. Only applies to the VU category Restricted area of occupancy or number of locations with a plausible future threat that could drive the species to critically endangered or Extinct in a very short time.		-	-	D2. Typically: AoO < 20 km <sup>2</sup> or number of locations ≤ 5

### Evidence:


#### Eligible under criterion D2 as Vulnerable

The taxon is observed to be very restricted.

Criterion E (Quantitative Analysis) was not addressed as the taxon does not have a detailed Population Viability Analysis.

### References

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