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Coppice treatment gives hope to a rare and endangered mallee eucalypt in the south-west of Western Australia.

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Abstract

Eucalyptus phylacis is a critically endangered mallee eucalypt known from a single clonal population of 27 ramets in the south-west of Western Australia. The clone is estimated to be about 6400 years old but was only recently discovered. Prior to its discovery, part of the population was destroyed during the construction of a road. More recently the health of the population has declined and is threatened by a stem canker pathogen. This paper discusses the use of coppice treatment as a method of combating canker disease and restoring the health and vigour of the ramets within the population.

Keywords: *Eucalyptus phylacis*, meelup mallee, rare plant, clonal eucalypt, coppice

Introduction

Eucalyptus phylacis L.A.S.Johnson & K.D.Hill is a small mallee or tree up to 5 m tall, with distinctive rough and flaky bark on the stems, and produces creamy white flowers in February and March. It is commonly known as the Meelup mallee. It was only recently discovered and described (Hill and Johnson 1992) and survives as a single population in the Meelup Regional Park approximately 200 km south of Perth, Western Australia (Kelly *et al*. 1995). RAPD analysis showed that the population is made up of a single clone (Rossetto *et al.* 1999) comprising 27 known ramets (an individual plant derived from a clone) within an area of 0.09 ha. Based on the total area that the ramets occupy and assuming a peripheral growth rate of 0.5 cm year^{-1}, Rossetto *et al.* (1999) estimated the clone to be about 6400 years old, suggesting that it is potentially the oldest eucalypt plant on record. *E. phylacis* is thought to be a hybrid as it does not produce viable seed, despite producing masses of flowers annually and forming fruit. It grows on a loamy lateritic ridge near the coast in woodland dominated by *E. marginata* and *Corymbia callophylla.* It is also within the geographic range of another closely related mallee, *E. decipiens*.

E. phylacis was originally discovered in 1981 by N. Marchant from the Western Australain Herbarium and the original collection made by K.H. Rechinger in 1982. It was declared as Rare Flora in 1987 under the *Wildlife Conservation Act* 1950 and ranked as Critically Endangered in 2003. The main threats to it are poor genetic diversity, poor regeneration, insect and fungal threats, modified fire regimes and road maintenance activities (Patten *et al.* 2004). Originally the population was larger, but prior to its discovery road construction (pre 1955), subsequent realignment and the development of a scenic lookout (between 1955 and 1966) destroyed an unknown number of ramets. Once the significance of the plant became known, access to the lookout was restricted and in 2002 a new lookout was constructed and the original site rehabilitated. In the early 1990s, damage by wood boring insects and canker development in the bark was observed on many stems. A number of canker-causing fungi, including *Botrysphaeria australis*, have recently been isolated and identified (Scott 2003). A large number of stems within the population have died and bark splitting (Fig.1a) and severe canker development (Fig. 1b,c) is evident on almost all the remaining stems. Meanwhile, an Interim Recovery Plan has been completed (Patten *et al.* 2004) that describes other management options that are being explored to aid the recovery and to promote the health of the population.

One practical option available for the recovery of *E. phylacis* is to coppice the ramets in order to promote new vigorous healthy growth. It is well known that mallee eucalypts re-sprout following fire (Noble *et al*. 1980, Noble 2001) and following removal of the stems by cutting (Noble 1982). Both events result in the rapid development of a multi stemmed habit arising from a woody rootstock or lignotuber (Noble 2001). It is also recognised that healthy vigorous plants are more resistant to pathogen attack and that canker diseases are more common in stressed and ageing individuals (Old and Davison 2000). Local records and knowledge suggest that the *E. phylacis* population has not experienced fire for 16 or more years. In contrast, many mallee environments are burnt regularly and mallee populations can regenerate freely from single fires every 5–10 years (Noble 1989). Therefore we suggest that the plants within the population are ageing, losing their vigour and are thus more prone to canker disease. In order to investigate whether *E. phylacis* will regenerate following fire or stem removal one of the 27 individual ramets was selected for mechanical coppice treatment. The results are reported here.

Figure 1. Canker damage common on stems of *E. phylacis*. A, superficial split in bark (bar = 5 cm); B, severe canker (bar = 5 cm); C, cross section of stem in Fig. 2b showing decay and discolouration of wood (bar = 5 cm).

Table 1

Attributes of stems removed from a coppiced ***E. phylacis* ramet.**

Stem #	Diameter (mm) at: Base	1.3 m	Bark thickness (mm) at: Base	1.3 m	Age (years)
1	98	66	–	–	Dead
2	171.5	103.5	15.5	15	20
3	102	71	16	11	16
4	75.5	58	13	9.5	13
5	85	53.8	12	9	20
6	62	54.5	–	–	Dead
7	185	137	15	15.5	20

Methods

Coppice treatment

In June 2001, a single ramet of *E. phylacis* was selected (on the basis of it being the one most severely affected by bark cankers) for coppice treatment. This involved severing all the stems at 25 mm above the lignotuber with a chainsaw. The selected ramet had seven stems, two of which were dead and five were severely affected by canker. All equipment was sterilised, and Steri-Prune wound sealant (Balchan International, Mulgrave, NSW), a bitumen-based product, was applied to the surface of all cut stems. Sections, 30 mm thick, were cut from the base of each stem and used to estimate the age of each stem by ring counts and to measure bark thickness. The remainder of the removed material was taken away and burnt and the ash then returned to the site and spread around the stump. The stump was protected from browsing animals with a wire cage.

Fire history

The date of the last fire was estimated using local Shire records, site inspection, aerial photos and the estimated ages of the removed *E. phylacis* stems. Each ramet was also inspected for signs of past fire damage in the form of burnt stem stumps and evidence of charcoal on the bark at the base of existing stems. *Hakea trifurcata* was the dominant shrub species present, and three *H. trifurcata* stems from within or immediately adjacent to the *E. phylacis* population were also removed and their ages estimated by ring counts. *H. trifurcata* is a species that regenerates from seed following fire, and their age is likely to indicate the time of the last fire. Ring counts were obtained using air-dried discs cut from the base of each stem. The surface of each disc was smoothed with a plane and sandpaper and two diameters were pencilled at right angles on each surface. Rings were counted visually or with assistance of a stereomicroscope using 6x or 10x magnification (Mucha 1979). Moistening the surface with water also made the rings appear clearer.

Table 2

Diameter (at 25mm above ground) and height of new coppice growth 24 months after cutting treatment to a ramet of ***E. phylacis*.**

Stem	Diameter (mm)	Height (cm)
1	10	110
2	45	250
3	40	230
4	30	250
5	20	180
6	45	230
7	40	210

Results

Stem age and bark thickness of *E. phylacis*

The estimated ages of the removed stems ranged from 13–20 years with diameters at breast height from 55–185 mm. The rhytidome (outer bark) was thin and flaky, about 1–2 mm thick, while the living inner bark was quite thick, ranging from 10–14 mm at the base and 6–14 mm at 1.3m height (Table 1).

Fire

Shire records indicate that a wildfire occurred immediately adjacent to and down slope from the *E. phylacis* population in 1985, 16 years previous to the study. Evidence of charcoal and burnt stem stumps on 70% of the *E. phylacis* ramets and standing dead stems with fire scars present on both *E. phylacis* and *C. calophylla* suggest that the 1985 fire entered the population and burnt the majority of the ramets. Ring counts estimated that the ages of the removed *H. trifurcata* plants were 12, 12 and 14 years. Comparing aerial photos from 1980 and 1992 did not show conclusive evidence or the boundary of the fire reported in 1985.

Coppice development

Three months after treatment, four new shoots were emerging from two of the stumps of main stems. Two months later, the resulting coppice had grown to about 30 cm in height (Fig. 2a). Fifteen months after treatment the coppice from the lignotuber was about 2 m tall and consisted of 10 vigorous stems (Fig. 2b) and 24 months after treatment 6 stems, 20–45 mm in diameter, had grown to 3 m or more in height and dominated the development (Table 2, Fig. 2c). Four of the stumps from the original stems produced new coppice while two stems of the new coppice arose from the surface of the lignotuber.

Discussion

Clonal development in lignotuber-forming mallee eucalypts appears to be more common in situations that

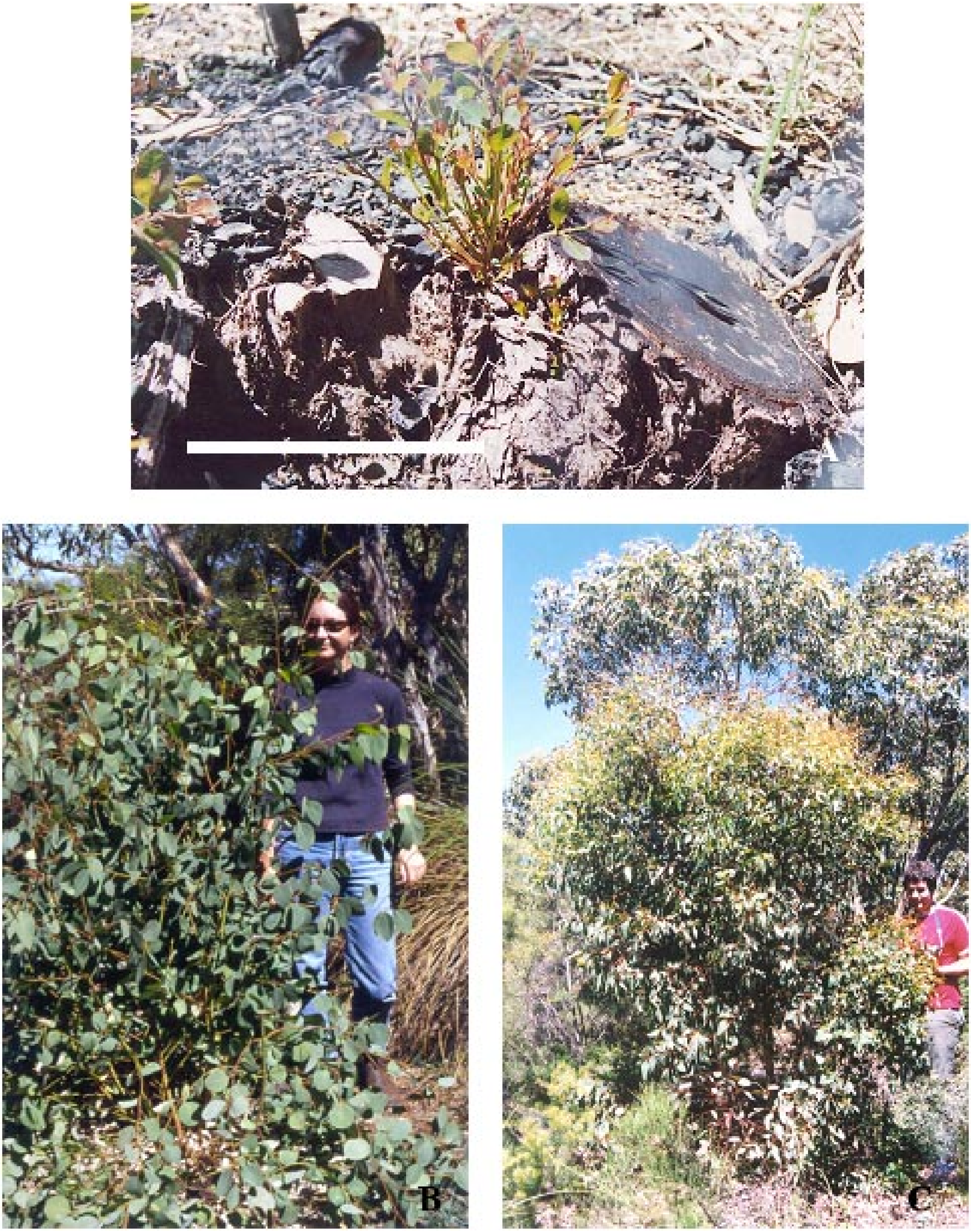

Figure 2. Shoot and coppice development following removal of stems from an *E. phylacis* ramet. A, shoot development 5 months after treatment (bar = 15 cm); B, coppice development (about 1.8 m tall) with juvenile foliage 15 months after treatment; C, coppice development (about 3.2 m tall) with adult foliage 24 months after treatment. The mature ramet in the background is approximately 4.5 m tall.

favour lateral growth such as sites with high light availability, limited soil nutrients and frequent fire (Noble 1982). Observation of the surrounding landscape suggests that the area has not been burnt for many years. The presence of burnt stem stumps and burnt dead stems along with the ring counts of the removed *E. phylacis* stems suggests that a fire may have burnt at least part of the mallee population 16 years previously. The main population is quite fragmented due to past road construction and is split into four distinct groups. The group in which the coppiced ramet exists was likely to have been exposed to the fire, but the other groups have the protection of a wide cleared gravel area between them and the shrub-covered slope below. The larger stem diameters of the 'protected' ramets (Scott 2003) also suggests that they are older and probably escaped being burnt or if they were burnt their stems were not killed. The thick bark on *E. phylacis* stems (Table 1) suggests that they could survive a fire of moderate intensity (Vines 1968). The ring counts of the *H. trifurcata* shrubs also indicate that the 1985 fire burnt the slope directly below the mallee population.

After a canopy killing fire, mature mallee plants re-sprout from a large lignotuber (Noble 1982, Gill 1997), and within Australia's mallee region, many eucalypts are maintained in a youthful form either through regular burning and/or edaphic factors (Beadle 1968, Noble 1982). It has been suggested that fire can be managed for the benefit of some mallee communities and, for mallee communities in the arid region of southern Australia, Noble (1982) suggested a fire interval of about 10 years. In lieu of fire, however, mallee eucalypts will re-sprout successfully following removal of stems by cutting, both in the spring or the autumn (Noble 1982). Two years following coppice treatment, the *E. phylacis* ramet had attained a height of more than 2 m with 6 dominant stems. Noble (1982, 2001), however, also showed that autumn burning or coppice treatment two years in a row killed mallee eucalypts, but the same treatment in spring resulted in few tree deaths.

In natural environments, it is generally accepted that high incidence and severity of cankers are associated with environmental stress (Old and Davison 2000) or alternatively low tree vigour, which is common in older, over-mature plants. Generally, vigorous healthy trees are more resistant to attack from both insect pests and fungal pathogens. In the case of the *E. phylacis* population, we hypothesised that the individual ramets are over-mature and that their vigour will be reinstated by promoting new, healthy growth either by burning or by stem removal by cutting which will promote coppice development. Future monitoring will determine whether the coppice will be resistant to infection and canker development, but after 2 years all stems are canker free.

While tissue culture may secure the future of rare eucalypts, including *E. phylacis* (Bunn 2001) it will not save the individual ramets in the population at Meelup. The future of the present *E. phylacis* population depends on rejuvenating the health of the stand. It would appear that fire might be an appropriate tool, as has possibility been the case for the past six millennia, and intervals of 10–15 years may keep the population physically viable and with sufficient vigour to resist fungal pathogens.

However, because of the location of the site and the situation of the species it may not be practical or wise. For example, other factors such as the fire interval required for reproduction in other associated species in the habitat, and the proximity of the population to urban and other public areas also needs to be considered. The greatest threats to restricted species such as *E. phylacis* are catastrophic events or further disturbance that will lead to extinction (Rossetto *et al*. 1999). Burning the entire population in a single fire event may not, therefore, be desirable, and if burnt it may need to be protected from repeated fire for several years in order to ensure complete regeneration. But the fragmented nature of the population does provide a possibility of reducing the risk associated with burning the entire population.

An alternative that we propose is a program of gradual coppice treatment to be initiated, where one or two ramets are coppiced in the spring every 1–3 years. A 10–15 year program will result in the rejuvenation and ensure the future of the entire population. Because of the Critically Endangered and Declared Rare status of *E. phylacis*, only one ramet was selected for treatment, but it was the one considered as having the most advanced symptoms of infection and senescence. The result shows promise for the other ramets within the population. When the health and vigour of the entire population is restored, it is feasible that some of the major environmental threats to the species will be abated and future management of the population could be integrated into the overall management of the reserve, which may include fire. If managed successfully, *E. phylacis* will always be rare, but need not be endangered.

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