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Tuart decline

Eucalyptus gomphocephala

RESEARCH FINDINGS

Tuart Bulletin No.3 A series outlining key research findings associated with tuart health in south-west Western Australia

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The role of water relations in the health of tuart

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Reduced rainfall in south-western Australia (Indian Ocean Climate Initiative 2002) has been suggested as a possible mechanism for the decline of several native tree species.

*Declining tuarts (*Eucalyptus gomphocephala*).*

Most of these species are large canopy emergents from the genus *Eucalyptus* and are iconic elements of south western Australian forests. Members of this genus are renowned as opportunistic scavengers of soil water, capable of exploiting deep groundwater pools (Bell and Williams 1997), but are also considered to have clearly defined geographical distributions associated with local environmental conditions such as soil type and rainfall (Hughes *et al.* 1996). Under the scenario that reduced rainfall has compounded the effect of the annual summer dry season in south western Australia, by either directly reducing soil moisture or lowering water tables, species formerly adapted to more mesic conditions will be disadvantaged.

Indeed, since woody plants may operate close to the point of catastrophic xylem dysfunction (Tyree and Sperry 1988), such conditions could invoke the decline of susceptible species by increasing the likelihood of xylem embolism formation.

Eucalyptus gomphocephala D. C. is a species showing the characteristic signs of decline, reduced canopy condition and mortality, particularly in the vicinity of Yalgorup National Park (32.90S; 115.69E), while co-occurring species of this same area appear largely unaffected. In an effort to test the hypothesis that a reduction in rainfall is the direct cause of this decline, an interspecific comparison of vulnerability to cavitation was undertaken to provide insight into the decline event. In addition to *E. gomphocephala*, the species assessed for vulnerability to cavitation comprised two further members of the family Myrtaceae (*Eucalyptus marginata* Sm. and *Agonis flexuosa* (Wild.) Sweet) and one from the family Fabaceae (*Acacia cyclops* G. Don). This small but locally diverse group of plants represents canopy species that currently co-occur with *E. gomphocephala* in Yalgorup National Park.

Methods

Vulnerability to xylem embolism was determined as the relationship between percentage loss hydraulic conductivity (PLC) and xylem water potential (Ψ_x) (Sperry and Tyree 1988). All stems were collected (and immediately transported to the laboratory) from Yalgorup National Park. Stems were initially 35-40 cm long but were trimmed with a razor blade under distilled water in the laboratory to 25-30 cm long, representing a length longer than the measured vessel size of each species. Cavitation events were induced by the air injection principle (Sperry and Saliendra 1994). Briefly, a stem segment was inserted inside a pressure collar and the ends attached to an apparatus designed to measure flow rates through stems.

Monitoring.

A collaboration of Government, research and industry partners supporting research into tree decline science and management in south-west Western Australia. **www.tuarthealth.murdoch.edu.au**

This comprised of a section of peekTM resistance tubing ordered in series with the stem segment. The measured relationship between the pressure drop across the peek™ tubing (which was maintained to less than 5 kPa during measurements) and flow rate (k_h, kg s^{-1}) permitted determination of stem flow rate. An initial maximum measurement of k_h (k_{max}) was made after flushing the stem with a filtered (0.11 Ψm) degassed perfusion solution (1 mM KCl). Air was then injected into the collar to a desired pressure, equivalent to the water potential of xylem ($-\Psi_x$), and maintained for 15 minutes. The pressure was then slowly released and kh remeasured. This procedure was repeated to progressively higher pressures and the relationship between percentage loss hydraulic conductivity (PLC) and Ψ_x determined:

A dose response sigmoidal model was fitted to plots of PLC versus $-\Psi_x$:

$$PLC = \frac{100}{1+10(\log b - \Psi_x)\,a}$$

where *a* is the gradient of the curve and log *b* is Ψ_x where PLC = 50 (denoted here as PLC_{50}).

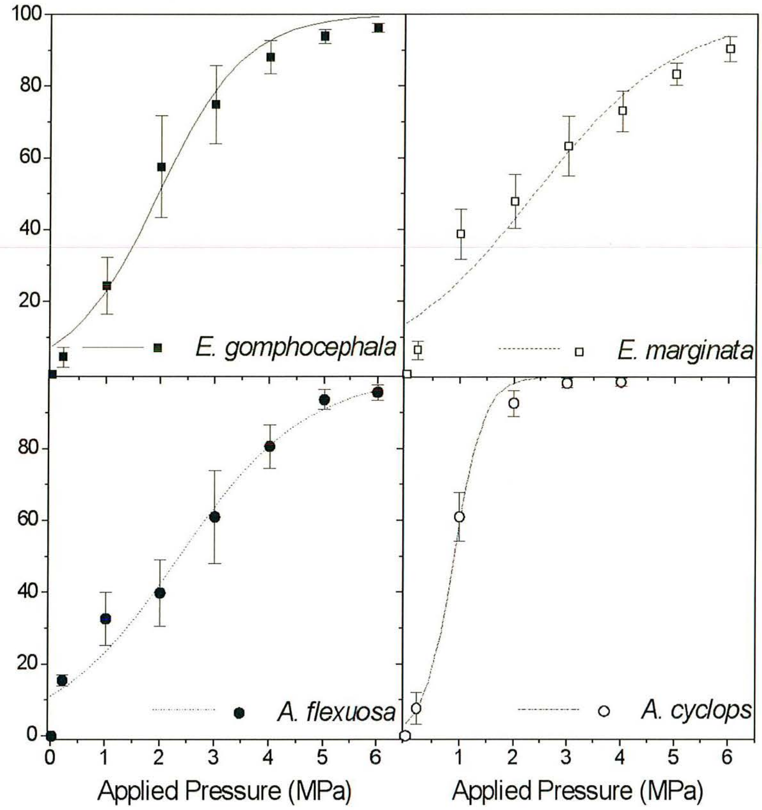

Figure 1: Vulnerability curves, plots of PLC versus applied pressure ($-\Psi_x$), for E. gomphocephala, E. marginata, A. flexuosa, and A. cyclops. *The fitted lines are dose-response sigmoidal models. Each point is the mean ± s. e. (n = 5).*

Results

Vulnerability curves (Figure 1) suggest that the Mytaceous species of this study have a similar cavitation response with progressive exposure to tension in xylem, becoming fully embolised after pressure was induced to around 6 MPa. *Acacia cyclops*, on the other hand, became fully embolised at a much lower applied pressure, between 2 and 3 MPa.

Conclusion

Under the scenario that *E. gomphocephala* canopy dieback in Yalgorup National Park is related to reduced rainfall and an associated increase in the severity of the annual dry season, it could be argued that this species should express a heightened vulnerability to xylem embolism compared to co-occurring species that are not showing the symptoms of a decline syndrome. The results of this study, however, are somewhat equivocal, with vulnerability to embolisms in *E. gomphocephala* not atypical of species that are not showing the outward expression of a decline syndrome. Further study capturing *in situ* water relations patterns in a range of species would clarify this uncertainty.

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