Ecology of *Phyla canescens* (Verbenaceae) in Australia

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A thesis submitted for the degree of Doctor of Philosophy of the University of New England

May 2008

Acknowledgments

Thank you to my supervisors, Wal Whalley, John Duggin, Brian Sindel and Mic Julien. Duggo for getting the ball rolling, Brian and Mic for keeping it on track, and Wal for picking it back up out of the mud. Particularly thanks to Wal for being incessantly positive, without which I would never have finished. Wal provided feedback on drafts of all chapters, while Brian and Mic did so for Chapters 2–8. I also thank Liisa Atherton for proof-reading a thesis draft.

Rieks van Klinken, Jodi Price, Mohammad Fatemi and Caroline Gross provided food for thought. Duggo, Mic, Rieks, Caroline, Judy Earl, Rob McCosker, Steven Peart and Dan Macdonald provided specimens and/or specimen data. Andrew Boulton provided some advice on statistics.

Thanks also to the UNE technical staff, particularly Trevor Stace for his enthusiasm and ingenuity, Paul Lisle and Jim Fittler for robust field assistance, Richard Willis for laboratory help, Cate McGregor for GIS and Jim O'Neil for IT support. Thanks also to Tom Hillard, UNE Facilities Management Services, for lending field equipment. I was fortunate to benefit from their experience and generosity before many were 'rationalised'.

Landholders, John & Robyn Watson, James Kahl, Bruce & Jen Southeron and Phillip & Terri Fleming, kindly allowed access to their properties. The members of the Murray Darling Basin Lippia Working Group successfully lobbied for this project to be funded. Its chair, Tony Woods, I thank for his unquenchable enthusiasm and good humour (though not always in good taste).

The herbaria AD, BRI, CANB, DNA, HO, MEL, NE, NSW and PERTH provided access to specimens and data. The Australian Botanical Liaison Officers, Annette Wilson, arranged for digital scans of specimens held at KEW, and Alex George, obtained an image of the type specimen from P.

Thanks also to fellow students and friends for various combinations of discussion, coffee, and accommodation. Thanks particularly to Kim, Austin, Layla, Mick, Kate, Keano, Meg, Nick, Doug, Jo, Darrell, Toro, Jodi and Orange for graciously suffering impositions. My family, as always, provided support and perspective. Finally, I would like to thank Emma for her patience and love throughout, particularly when I was most losing the plot.

This project was funded by the CRC for Australian Weed Management, Australian Cotton CRC, UNE, CSIRO and the Wal Whalley discretionary fund.

All photographs and mistakes are my own.

Abstract

Phyla canescens has invaded large areas of wetland and grassland on floodplains in Australia, particularly the Murray Darling Basin, where *P. canescens* threatens the sustainability of internationally significant wetlands and the viability of grazing enterprises. The species was introduced into Australia from South America, where it is a common and widespread species of floodplains and waterways, particularly in areas subject to constant grazing, or otherwise continuously disturbed. It has been promoted in Australia and elsewhere as a hardy groundcover for its perceived aesthetic and soil conservation values. *Phyla canescens* continues to be sold in the horticulture industry, invariably labelled '*Phyla nodiflora*'; a closely related species with which it is frequently confused. Both species are generally associated with waterways and floodplains and share a prostrate habit, with adventitious roots developing at each node along the numerous, intertwining stolons. Both species form dense mats to the exclusion of other vegetation. While *P. canescens* has typically smaller features and inhabits more southerly, inland areas with heavy clay soils, the coarser *P. nodiflora* is more common in northern, coastal regions with sandy soils.

The general lack of quantitative information on fundamental aspects of the life-history of *P. canescens* is a substantial impediment to the development of sustainable and ecologically sound management protocols for this species, including biological control, and the communities which it invades. Experiments were devised to help address this information gap, the results of which are presented in this thesis.

A thermogradient plate was used to examine the germination response of *P. canescens* seed to a variety of temperature regimes. *Phyla canescens* seed from two separate populations was found to require temperatures that alternated by at least 5°C, a response for which the term homothermophobia is suggested. The presence of light and high water availability were also necessary for germination. This particular combination of germination requirements is common to a number of invasive species of wetland and floodplain habitats. The conditions to fulfil this set of germination requirements are likely to be met most abundantly following the recession of floodwaters.

Four field populations were selected in two adjacent catchments (Gwydir River and Namoi River) in the northern New South Wales section of the Murray Darling Basin. At each site, permanent quadrats were established inside livestock exclosures, with experiments designed to estimate seed production, seedbank density and longevity, and response to seasonal disturbances.

Seed production was estimated to reach over 60 000 seeds m^{-2} yr^{-1}. All seeds were produced in the five-month period between the end of November and the beginning of May. Apart from time of year, seed production was also a function of recent rainfall, percentage cover of *P. canescens*, and cover of other species. Where pollinators were excluded from virgin inflorescences, fruit set was reduced from 51%, with pollinator access, to zero.

Previous estimates of the *P. canescens* seedbank are low, both in Australia and Argentina. However, by germinating seed under ideal conditions, from soil cores reduced in volume by wet sieving, seedbank density exceeded 7500 seeds m^{-2}. After 12 months of preventing seed-rain, the seedbank across the four sites had decreased by 38%. At this rate (assuming negative exponentiality) it will take 10 years for the seedbank to decline to <1% of the original density. However, a parallel seed-burial study showed no significant decline over 13 months. Such seed burial experiments have been criticised for over-estimating rates of decline, but clearly this is not the case here. Overall, seedbanks of *P. canescens* are likely to be a management concern for approximately a decade for sites where seed-rain is eliminated from areas with previously high cover of *P. canescens*. However, floods are likely to increase the rate of seedbank depletion, primarily through germination of those seeds exposed to light.

Following four seasonal disturbances at each site, germination of *P. canescens* occurred only at one site that experienced a flood during the experimental period. The exclosures at the other sites were not flooded and no *P. canescens* germinated, despite periods of high rainfall, and germination of a range of other species. Germination density and seedling survivorship were both reduced in the presence of existing vegetation. An opportunistic survey, following the flooding of a billabong, revealed recruitment of *P. canescens* from both seed and fragments to be almost exclusively restricted to the area that had been flooded. Seedlings were also recorded germinating directly from sheep faeces.

In summary, recruitment of *P. canescens* from both seeds and vegetative fragments appear limited to periods following inundation; seed production is reduced with higher cover of other species and reduced cover of *P. canescens*; both germination and seedling survival are reduced in the presence of existing vegetation cover. It is therefore suggested that by implementing grazing regimes that maximise the cover of competing species at the time of, and following, flood events, the seed production, germination and recruitment of *P. canescens* can be minimised.

Certification

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

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M. J. Macdonald

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