Why do plants become invasive?

The role of phylogeny, herbivores and time

Kerinne Jean-Maree Harvey

BSc (Hons)

Macquarie University

and the Australian Museum

Thesis submitted for the degree of Doctor of Philosophy

MAY 2012

Contents

Abstract

Invasive plants are a global problem, with significant environmental and economic consequences. Reducing the risk that introduced species become invasive is a high biosecurity priority. Much research has been directed at identifying particular biological traits associated with invasion success. Despite some progress in identifying mechanisms and traits associated with successful invasive species, we are still a long way from making generalisations about invasion success among species and communities. The idea that phylogenetic relationships between species may be important in determining the establishment and naturalisation of non-native species was first put forward by Charles Darwin as his 'naturalisation' hypothesis. This idea proposes that upon introduction, non-native species are less likely to naturalise if they have native near relatives due to competition for similar resources or alternatively because they are more likely to be attacked by pre-adapted native natural enemies. This study was aimed at investigating whether an understanding of time since introduction, and phylogenetic relatedness of introduced species relative to the community into which they are introduced, can be used to predict their invasive risk due to the likelihood of control by natural enemies.

I examined patterns of herbivore and pathogen damage, and the abundance and richness of invertebrate communities on introduced and native plants in eastern Australia. Comparisons were made at two taxonomic levels, above and below genus. At genus level and above, 37% of variation in leaf damage across 14 invasive plants was predicted by the phylogenetic distance to the nearest native relative. As phylogenetic distance between the introduced and native plants increased, leaf damage decreased. This result indicates that phylogenetic relatedness of invasive plants to species in native communities is a useful tool for assessing the likelihood that plants will accumulate a community of natural enemies

from that community which may influence their invasive potential (Chapter 2). Within-genus predictions of success of invasive species could not be based on phylogeny (Chapter 3; Chapter 4). Damage to non-native *Senecio* species was less than on natives, but no difference in damage was found between invasive *Senecio madagascariensis* Poir. and other non-invasive *Senecio* species. *Senecio madagascariensis* had greater herbivore loads than native *Senecio* species (Chapter 3; 4). Herbivore loads increased over time on *S. madagascariensis*, but this did not equate to enemy release at early stages of invasion (Chapter 4). High leaf damage occurred where *S. madagascariensis* had recently colonised, even though this was also where there was a low herbivore load. At the introduction site damage was low, and herbivore loads high (Chapter 4). A complex relationship exists between an invader and invertebrate community response at fine taxonomic scales. This may be a result of changing selective pressures on an invasive species over time. Phylogenetic distance between non-native species and native recipient communities is recommended as a management tool for predicting the likelihood that species will become invasive at broad phylogenetic scales.

Statement of original authorship

I, Kerinne Harvey, hereby declare that the work in this thesis was performed by myself unless stated otherwise and that it has not been presented elsewhere for any other academic award. The papers presented in this thesis by publication are co-authored by my supervisors Lesley Hughes, David Nipperess and David Britton. Wherever people have assisted me in providing information, data collection and comments on manuscripts, they are acknowledged at the end of each chapter.

Kerinne Jean-Maree Harvey

May 2012

Acknowledgements

I am particularly grateful to my supervisors, Lesley Hughes, David Nipperess and David Britton for their support, advice and input throughout this project. Thank you.

I would like to thank my family and friends for their continued support over the years. In particular I would like to thank my friend Kate Umbers and for fieldwork support and for her patience and time reading over manuscripts. To my sister in-law Jennifer Harvey, thank you for your time and contribution to reading and editing manuscripts. There have been many fieldwork assistants that have all accompanied me on long drives including John Martin, Katherine McClellan, Katy Wilkins, Hayley Given, Kate Umbers and my parents Laurel and Bill Harvey. Thank you to you all. Katy Wilkins I'd like to thank for her great contribution to lab work and fieldwork assistance. John Martin accompanied me on many field trips and contributed to many research discussions. Thank you. Thank you to the postgraduate students of Macquarie University and Staff. In particular I'd like to thank postgraduate students of Macquarie University and friends Julia Cooke, Matthew Bulbert, Vince Repaci and Katherine McClellan that have contributed to support and many discussions.

The present and past technical and administrative staff in the Biology department have been a great support. Thanks to Craig Angus for fieldwork safety, Marie Howitt, Sharyon O'Donnell, Julia Wee and Laura McMillan for dealing with forms and finances quickly and smoothly and to Muhammad Masood for support in the glasshouse. Also thank you to technical staff including Marita Holley, Ray Cameron and Sancha Regtop. Michelle Power, Vince Repaci, Kate Umbers, Nik Tatarnic and David Nipperess have all assisted in helping me understand the world of phylogenetics. Thanks.

I would also like to thank the Plant Interactions and Climate Change Ecology Lab members past and present including Lesley Hughes (Head of Lab), David Nipperess, Katherine McClellan, Robyn Sinclair, Andres Roubicek, Linda Beaumont, Rachael Gallagher, Alex Bush, Abigail Cabrelli, Nola Hancock, and Sabine Nooten for discussions over many cups of tea.

Several taxonomists have contributed to identifying and verifying invertebrate identifications and include: David Britton, Derek Smith, David McAlpine and Jacquie Rescei of the Australian Museum and Bruce Halliday and Laurence Mound of CSIRO Ecosystem Services Canberra. Many people have assisted with their knowledge for plant location data and have been acknowledged within each chapter. However, I would particularly like to thank Alison Downing of the Downing Herbarium Macquarie University for her assistance with plant identifications. Also I'd like to thank the late Anders Bofeldt for his enthuasism and the time he spent assisting me finding *Senecio* species in the Illawarra district, thank you.

I am also am very grateful to Todd Minchinton and Marie Herbestein for allowing me to knock on their door many times for advice and support over the years.

I'd also like to thank John Hosking and Royce Holtkamp of the Tamworth Agricultural Institute for their assistance with plant location data for *Senecio* species and aspects of methodology including advise on rearing insects.

There are many others that have assisted in various aspects of my research that I have missed here but are separately acknowledged within each data chapter.

Finally to Simon Schubert and Vali Clarke, you have opened your hearts and your home to me, given me much happiness and plenty of comic relief. Thanks.