



Resource dynamics and positive and negative interactions between plants in arid systems

Jane Prider

Department of Environmental Biology
The University of Adelaide

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Contents

Abstract.....	vi
Declaration	vii
Acknowledgments	viii
CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW: PLANT INTERACTIONS ALONG SPATIAL AND TEMPORAL RESOURCE GRADIENTS.....	1
Introduction	1
<i>Resource gradients</i>	1
<i>Resource gradients in arid systems</i>	2
<i>Gradients and plant interactions</i>	3
<i>Thesis scope</i>	3
Temporal gradients and the supply of resources.....	4
<i>Plant responses to pulsed resources</i>	5
Spatial gradients: habitat modification and facilitation.....	6
<i>Below-ground resource enrichment</i>	6
<i>Facilitation mechanisms</i>	7
Facilitation and gradients	9
Competition and gradients.....	10
<i>Pulsed resources and competition</i>	11
Balance between facilitation and competition.....	13
<i>Temporal shifts</i>	14
<i>Plant life stage</i>	14
<i>Fertility islands</i>	15
<i>Physiology</i>	16
Conceptual model.....	16
General research aims.....	17
CHAPTER 2: STUDY SITE AND STUDY SPECIES.....	20
Introduction	20
Study site	20
Climate	21
Vegetation.....	21
Species descriptions.....	22
<i>Acacia papyrocarpa</i>	22
<i>Atriplex vesicaria</i>	23
<i>Maireana sedifolia</i>	23
<i>Enchylaena tomentosa</i>	24
<i>Rhagodia spinescens</i>	24
CHAPTER 3: VEGETATION RESPONSES TO PULSES AND PATCHINESS.....	26
Introduction	26
Methods	27
<i>Study site</i>	27
<i>Soil water content</i>	28
<i>Biomass surveys</i>	28
<i>Perennial shrub growth</i>	29

<i>Analyses</i>	30
Results	31
<i>Pulses</i>	31
<i>Soil water content</i>	31
<i>Diversity</i>	32
<i>Biomass</i>	32
<i>Perennial shrub growth</i>	33
Discussion	34
<i>Soil water content</i>	34
<i>Pulse effects on biomass production</i>	35
<i>Effects of patchiness</i>	37
Summary and conclusions	38
Tables and figures	40

CHAPTER 4: CHANGES IN COMPETITION INTENSITY ALONG TEMPORAL AND SPATIAL RESOURCE GRADIENTS.....51

Introduction	51
Methods	53
<i>Experimental design</i>	53
<i>Response variables</i>	53
<i>Analyses</i>	54
Results	56
<i>Shoot elongation</i>	56
<i>Competition and soil moisture</i>	57
<i>Reproduction</i>	58
<i>Survival</i>	58
Discussion	58
<i>Spatial responses</i>	59
<i>Temporal responses</i>	60
<i>Species responses</i>	62
<i>Soil moisture</i>	63
Summary and conclusions	64
Tables and figures	65

CHAPTER 5: THE EFFECTS OF NITROGEN AVAILABILITY ON THE GROWTH AND RESPONSE TO COMPETITION OF ATRIPLEX VESICARIA.....79

Introduction	79
Methods	81
<i>Experimental design</i>	81
<i>Fertiliser application</i>	81
<i>Plant responses</i>	82
<i>Analyses</i>	83
Results	84
<i>Available nitrogen</i>	84
<i>Plant responses</i>	84
Discussion	85
<i>Responses to nitrogen addition</i>	86
<i>Leaf N content</i>	86
<i>Site effects</i>	88
<i>Competition</i>	88

<i>Sources of variability</i>	89
Summary and conclusions.....	89
Tables and figures.....	91

CHAPTER 6: TEMPORAL SHIFTS IN THE EFFECTS OF MICROCLIMATIC AND SOIL MODIFICATIONS BY ACACIA PAPHYROCARPA ON SHRUB PERFORMANCE.

.....	102
Introduction	102
Methods	104
<i>Study site</i>	104
<i>Experimental design</i>	104
<i>Canopy microclimate</i>	106
<i>Response variables</i>	106
<i>Analyses</i>	107
Results	109
<i>Canopy microclimates</i>	109
<i>Seedling emergence</i>	109
<i>Growth</i>	110
<i>Temporal responses</i>	110
<i>Relative interaction intensity</i>	111
<i>Survivorship</i>	112
Discussion.....	112
<i>Seedling emergence</i>	113
<i>Growth</i>	114
<i>Survivorship</i>	115
<i>Temporal responses</i>	116
Summary and conclusions.....	117
Tables and figures.....	119

CHAPTER 7: INTERACTIONS BETWEEN DROUGHT AND LIGHT ON THE WATER RELATIONS AND CARBON GAIN OF SEEDLINGS.....139

Introduction	139
Methods	141
<i>Experimental design</i>	141
<i>Plant responses</i>	141
<i>Analyses</i>	142
Results	143
<i>Drought period</i>	143
<i>Shoot water potential</i>	143
<i>Stomatal conductance</i>	144
<i>Photosynthetic rate</i>	144
<i>Biomass</i>	145
Discussion.....	146
<i>Water relations</i>	146
<i>Carbon gain</i>	147
<i>Soils</i>	148
Summary and conclusions.....	149
Tables and figures.....	151

CHAPTER 8: SUMMARY AND CONCLUSIONS.....	162
The nature of resource gradients	162
Facilitation.....	163
Competition.....	165
The balance between competition and facilitation.....	166
Conclusions	168
 APPENDIX 1.....	 170
 BIBLIOGRAPHY.....	 172

Abstract

In arid systems, below-ground resources fluctuate from being plentiful during pulses of rainfall to limiting to plant growth during interpulses between rainfall events. The role of plant interactions in structuring plant populations within systems with widely fluctuating resource levels is widely debated. I propose that the overall outcome of interactions along a temporal gradient of resource availability changes from positive during interpulses to negative during pulses.

I examined negative interactions between four co-dominant chenopod shrubs in arid *Acacia papyrocarpa* woodlands. Two chenopod shrubs, *Enchylaena tomentosa* and *Rhagodia spinescens*, occur almost exclusively beneath canopies. *Atriplex vesicaria* and *Maireana sedifolia* occur both beneath and in open sites between trees. Contrary to predictions, negative interactions were more intense when conditions were least productive. The intensity of competition between shrubs growing beneath canopies changed significantly over time and was least intense during a large pulse and most intense during a long interpulse. Competition was more intense in open sites than in the more fertile sites under trees. However, differences in soil fertility between sites did not explain the difference in competition intensity between sites.

Positive interactions between *Acacia* and *Enchylaena* and *Atriplex* seedlings also changed in intensity over time. Changes in positive interactions along temporal gradients depended on the facilitation mechanism. Supporting my prediction, microclimate modification by *Acacia* facilitated the survivorship of seedlings during interpulses in a dry year. However, modification of soil properties by *Acacia* facilitated seedling emergence and growth during pulses. *Enchylaena* grew more when protected by *Acacia* canopies but canopies had neutral to negative effects on *Atriplex* growth. Carbon uptake in pot-grown *Atriplex* seedlings was reduced when grown under light levels similar to those occurring beneath *Acacia* canopies. Carbon uptake in *Enchylaena* was not affected by shading when plants were well-watered but when plants were water stressed, high light levels had photoinhibitory effects.

Plant interactions seem to be most intense at the beginning of interpulses when plants are competing for diminishing water, or survivorship is enhanced in the favourable microsites provided by other plants. Later in the interpulse, interactions become less intense as conditions become more stressful and therefore survivorship and growth are affected more by abiotic conditions than plant interactions. In this system, positive interactions have an important role in determining the distribution of four dominant chenopod shrubs.