

**SPATIAL AND TEMPORAL PATTERNS IN
THE DRY SEASONAL SUBTROPICAL RAINFORESTS OF EASTERN
AUSTRALIA, WITH PARTICULAR REFERENCE TO THE VINE THICKETS
OF
CENTRAL AND SOUTHERN QUEENSLAND.**

William John Fancourt McDonald
B.Agr.Sc. (Qld) , M.Agr. Sc. (Qld)

April 1996

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

DECLARATION

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

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

A solid black rectangular box used to redact the signature of the author.

William J.F. McDonald

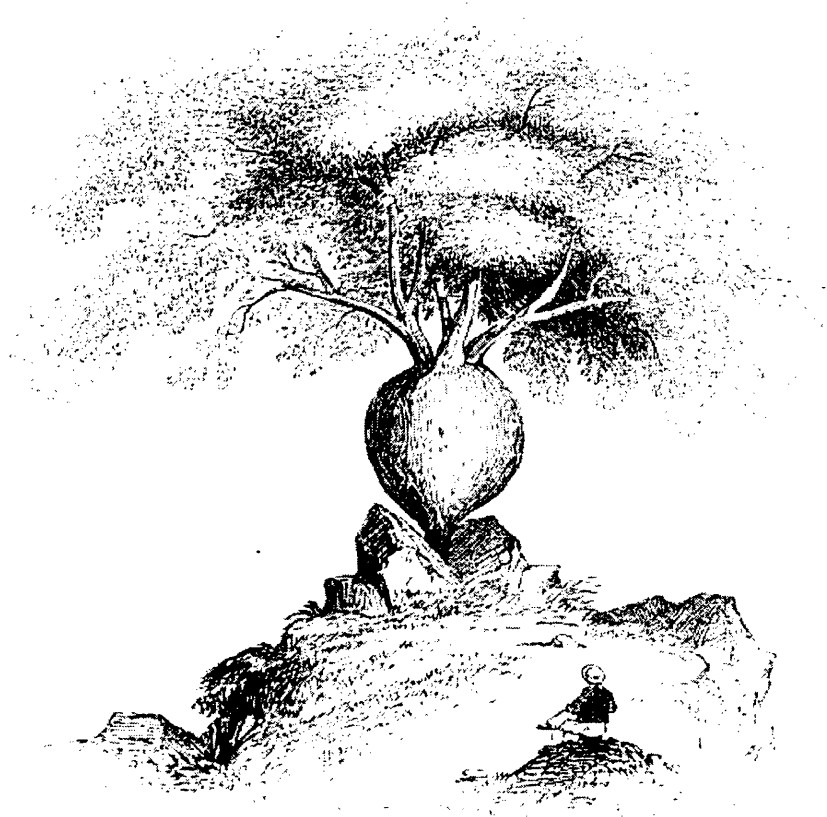
PROLOGUE

8th May (1846) --- - - - In hopes of obtaining an elevated view over the country to the westward, I endeavoured to ascend the northern summit of Mount Abundance, but although the surface to near the top was tolerably smooth, and the bush open, I was met there by rugged rocks, and a scrub of thorny bushes so formidable as to tear leathern overalls, and even my nose. - - - - The trees and bushes there were different from others in the immediate vicinity, and, to me, seemed chiefly new.

- - - Trees of a very droll form chiefly drew my attention here. The trunk bulged out in the middle like a barrel, to nearly twice the diameter at the ground, or of that at the first springing of the branches above. These were small in proportion to their great girth, and the whole tree looked very odd. - - - -

These trees grew here only in that almost inaccessible, crater-like hollow, which had impeded me in my attempt to reach the summit. Leaving the horses, however, I scrambled through the briars and up the rocks to the summit, but found it, after all this trouble, too thickly covered with scrub to afford me the desired view to the westward - - - -

From Mitchell, T.L. (1848) *Journal of an Expedition into the Interior of Tropical Australia, in Search of a route from Sydney to the Gulf of Carpentaria.*



Drawing by E.B. Kennedy of *Delabechea (Brachychiton) rupestris*, c. 10-15 km SE of Mt Sowerby, 15th May 1846.

ACKNOWLEDGMENTS

I would like to express my sincere gratitude to:

Dr Bob Johnson, formerly Director, Queensland Herbarium, who encouraged my interest in vine thickets, supported my application for study assistance and acted as my supervisor throughout this project. His tireless enthusiasm and cheerful companionship made for several memorable field trips and it has also been a privilege to collaborate in monitoring studies he initiated at Brigalow Research Station.

Mr John Williams, my co-supervisor, University of New England (UNE), for his guidance, support and helpful criticism during the preparation of the thesis. Also his wife Beth for her tolerance and generous sharing of her study/spare room.

Dr Colin Bale, New England Institute of TAFE, co-supervisor for the latter part of my candidature, for making time within a hectic schedule for valuable discussions and advice and for providing access to computing facilities.

Associate Professors N. Prakash and R.D.B. Whalley for their support as Botany Department Heads, and for providing work space for me at UNE, and Dr Jeremy Bruhl for acting as my principal supervisor for the past 18 months

Dr Gordon Guymmer, Chief Botanist, Queensland Herbarium, who has given me constant encouragement and support, and assisted my applications for leave of absence during the preparation of this thesis. Mr Des Boyland, Director, Conservation Strategy Branch and Acting Director, Division of Conservation, Department of Environment (QDE), for also supporting my requests for study leave.

Other Queensland Herbarium staff who have helped in various ways during this project. Hans Dillewaard set up a FOXPRO database for my survey data and guided my early use of PATN procedures. Peter Bostock coached me in MapInfo and solved many other difficulties with computer programs. Jan Johnson undertook library searches and drew my attention to various obscure publications. Will Smith prepared maps and dendrograms and Yvonne Smith formatted the thesis manuscript. Monica Humphrey provided administrative and other support.

Dr Rod Fensham for sharing his knowledge (and data) from the northern Brigalow Belt and providing valuable comments and advice during the preparation of the thesis.

Several colleagues and other friends who have shared field trips and assisted with description of survey plots during this project. Apart from Bob Johnson, these included Eric Anderson, Rhonda Melzer, Paul Grimshaw, Peter Young, Rod Fensham, Tracy Adams, Tony Bean, Bruce Wilson, Norman Gibson and Peter Macnicol. Bob and I were also assisted by Eric and Peter Macnicol during re-measurement of the Brigalow Research Station transect plots. Rhonda also made available unpublished data on soil seed banks and the effects of fire in a bonewood community at Ka Ka Mundi. Bob, John, Rhonda and Paul provided photographs.

QDE and Department of Primary Industries (QDPI) field staff who assisted with knowledge of, and access to, several vine thicket locations. Dennis Prendergast, Mundubbera, and Paul Lawless-Pyne, Springsure, were especially helpful.

Property owners who provided access to, and welcomed my interest in their "scrubs", including Adam Clark ("Bimbadeen"), John and Veronika Rolfe ("Telemon"), Bruce Kosh ("Oak Wells"), Peter Griffiths

("Stuart Downs"), John Kelman ("Bonnie Doon"), Dick Scanlan (Mt Berryman), the Turner family ("Blenheim"), the Bahnish family ("Cerberus"), the Carlisle family ("Wonga Hills") and the O'Keefe family ("Wallalee").

Beverley O'Keefe, "Wallalee", and Neil and Diane Hoy, Rockhampton, for assistance in various ways, and especially for providing data on propagation and rates of growth of many vine thicket tree species.

Bernie Powell, Bruce Forster and Terry Donellan of QDPI, who provided information on soils at, or in the general locality of, several of my sites.

Ms June McMahon and Professor Henry Nix, Centre for Resource and Environmental Studies, Australian National University, Canberra, for generating climatic (BIOCLIM) data for the 160 vine thicket sites.

Alan Lloyd and his staff at QDPI Brigalow Research Station, Theodore for providing accommodation over several visits, and for making available rainfall data for the past 30 years.

Jim Gasteen, whose wide field experience and interest in these communities were invaluable in the early stages of this project.

And most importantly my family, Gillian, John, Catriona and Erina, for their understanding, encouragement and loving support over the past few years. John also assisted with numerical and statistical analyses and processed growth data from Brigalow Research Station.

ABSTRACT

A study was undertaken of floristic patterns in remnant dry seasonal rainforest (semi-evergreen vine thicket) in central and southern Queensland. Quantitative (basal area and canopy cover) and binary vegetation data were collected from 75 sites using a multiple nearest-neighbours sampling technique. Areas covered by samples varied between 0.025 and almost 0.1 ha. Approximately half the sites occurred on fine-grained sediments, chiefly siltstone, shale and mudstone.

Mean numbers of species in sample of (32) canopy trees ranged from 14 in south-eastern Queensland to 7 in the Central Highlands region. Many of the latter stands were dominated by *Macropteranthes leichhardtii*.

Data were analysed using a range of classificatory and ordination procedures. An agglomerative procedure using the Bray-Curtis coefficient and UPGMA clustering provided more satisfactory groupings of sites than divisive methods. Eight site-groups were distinguished on the basis of cover data for tree and shrub species and were described in terms of structure, site features and frequent species.

Presence/absence data from the sites were incorporated into a regional floristic database covering the Brigalow Belt Biogeographic Region. There was broad agreement between the species and community patterns from the detailed survey and the bioregional analysis, with 3-4 coastal and subcoastal vine thicket groups and 3-4 inland groups.

The vine thickets represent a floristic continuum which is apparent in site and species ordinations. The latter indicate a large "core" group of species with other groups which represent northern/southern and dry/moist extremes of the continuum.

There was found to be close correlation between the community-types from both the detailed and the bioregional classifications and a range of climatic attributes, with coefficient of variation of monthly precipitation accounting for most significant between-group differences. Species diversity was also correlated with several climatic attributes, including (negatively) maximum temperature of warmest period.

Large-scale community patterns were studied in an area of vine thicket dominated by *Macropteranthes leichhardtii* (bonewood) and associated brigalow (*Acacia harpophylla*) communities at Brigalow Research Station near Theodore in central Queensland. A 1 km section of a permanent transect established by Johnson (1980) was chosen for studies of community/ site factor relationships and temporal patterns (i.e. the changes since establishment of the transect in 1968-70).

Macropteranthes leichhardtii was associated with duplex and gradational soils with relatively deep, light-textured A horizons, whereas the heavier clay soils carried a brigalow (*Acacia harpophylla*) - belah (*Casuarina cristata*) woodland. Areas of intermediate soils carried a brigalow/vine thicket community.

Over the 20-25 years since establishment of the transect, there have been significant changes in species composition and abundance in both the vine thicket and the brigalow/vine thicket communities. Numbers of species have increased overall in both communities, but abundance of some species, notably *Acacia harpophylla* and *Opuntia tomentosa*, declined. There has also been an increase in numbers of intermediate and larger stems (>2.5cm diameter), but an even larger decrease in smaller stems (>30cm high, but <2.5cm diameter). These results suggest that no effective recruitment has occurred since establishment of the transect.

The results from Brigalow Research Station are discussed in relation to broader species and community patterns in vine thickets.

TABLE OF CONTENTS

| | |
|---|-----------|
| Title Page | i |
| Prologue | ii |
| Declaration | iii |
| Acknowledgments | iv |
| Abstract | vi |
| Table of Contents | viii |
| List of Tables | xii |
| List of Figures | xvi |
| List of Plates | xix |
| List of Appendices | xxi |
| | |
| Chapter 1. Introduction | 1 |
| | |
| Chapter 2. Review of Literature and Statement of Objectives | 3 |
| 2.1 Australian "dry" rainforests - definitions, origins and affinities. | 3 |
| 2.1.1 A definition of "dry" rainforest | 3 |
| 2.1.2 Origins of Australian dry rainforests | 4 |
| 2.1.3 Affinities with seasonal rainforests in other continents | 6 |
| 2.2 Classificatory systems and frameworks for Australian rainforests. | 9 |
| 2.2.1 Structural classifications | 9 |
| 2.2.1.1 Structural/floristic approach | 9 |
| 2.2.1.2 Structural/physiognomic approach | 12 |
| 2.2.1.3 Other structural classifications | 14 |
| 2.2.2 Floristic classifications | 15 |
| 2.2.2.1 A floristic framework for Australian rainforests | 17 |
| 2.2.2.2 Environmental relationships of Australian rainforests | 19 |
| 2.3 Studies in Australian dry seasonal rainforest communities. | 22 |
| 2.3.1 Northern Australia | 22 |
| 2.3.2 Eastern Australia | 27 |
| 2.4 Temporal processes, with particular reference to Australian rainforests. | 30 |
| 2.4.1 Definition of succession | 30 |
| 2.4.2 Development of successional theory | 30 |
| 2.4.3 Studies of disturbance and succession in Australian rainforests | 34 |
| 2.4.4 Some aspects of succession, with respect to Australian rainforests | 37 |
| 2.4.4.1 Vegetative regeneration | 37 |
| 2.4.4.2 Single-species dominance | 38 |
| 2.4.4.3 Seed banks in Australian rainforests | 39 |
| 2.4.5 Studies of dynamics in dry seasonal forests | 39 |
| 2.5 Conclusions from review of literature. | 40 |
| 2.5.1 Dry seasonal rainforests in a global context | 40 |
| 2.5.2 Patterns in Australian dry seasonal rainforests | 42 |
| 2.6 Objectives of present study. | 43 |

| | |
|---|------------|
| Chapter 3. A Survey and Classification of Remnant Vine Thicket Stands in Central and Southern Queensland | 45 |
| 3.1 Definition of study area. | 47 |
| 3.2 Climatic environment. | 51 |
| 3.3 Survey methodology. | 55 |
| 3.3.1 Selection of survey sites | 55 |
| 3.3.2 Plot location and replication | 56 |
| 3.3.3 Plot enumeration and description | 59 |
| 3.3.3.1 Vegetation attributes | 59 |
| 3.3.3.2 Site attributes | 63 |
| 3.3.3.3 Climatic attributes | 64 |
| 3.4 Data processing and analysis. | 64 |
| 3.4.1 Description of data sets | 65 |
| 3.4.2 Numerical analyses | 66 |
| 3.4.3 Other statistical analyses | 70 |
| 3.5 Results of survey. | 70 |
| 3.5.1 Vine thicket plant taxa | 70 |
| 3.5.2 Structure and life forms | 72 |
| 3.5.3 Site attributes | 74 |
| 3.5.4 Vegetation data | 79 |
| 3.5.4.1 Biomass/abundance data | 79 |
| 3.5.4.2 Frequency of vine thicket species | 85 |
| 3.5.5 Species richness and evenness | 87 |
| 3.5.6 Species/area relationships and within-site variation | 91 |
| 3.6 Results of classification. | 96 |
| 3.6.1 Plot classifications | 96 |
| 3.6.1.1 Agglomerative procedure using quantitative data | 100 |
| 3.6.1.1.1 Relative importance data (analyses 1-4) | 100 |
| 3.6.1.1.2 Crown cover data (analyses 5-8) | 102 |
| 3.6.1.3 Floristic classifications (presence/absence data) | 103 |
| 3.6.1.2.4 Agglomerative procedure (analyses 9-12) | 103 |
| 3.6.1.2.5 Divisive procedure (analysis 13) | 104 |
| 3.6.2 Species classifications | 107 |
| 3.6.2.1 Presence/absence data | 107 |
| 3.6.2.2 Abundance (crown cover) data | 110 |
| 3.7 Preferred classification and description of vine thicket community-types. | 111 |
| 3.7.1 Vine thicket site-groups | 121 |
| 3.8 Environmental factors and vine thicket community patterns. | 131 |
| 3.8.1 Soil parent material | 131 |
| 3.8.2 Climatic attributes | 132 |
| 3.9 Discussion. | 133 |

Chapter 4. A Regional Context for Vine Thicket Communities - Floristic Patterns in the Brigalow Belt Biogeographic Region and Relationships with Environmental Attributes, particularly Climate

| | |
|---|------------|
| 4.1 The data set. | 143 |
| 4.2 Data analyses. | 148 |
| 4.3 Results. | 149 |
| 4.3.1 Site classifications | 149 |
| 4.3.1.1 Agglomerative classification | 149 |
| 4.3.1.2 Divisive classification | 149 |
| 4.3.2 Species classification | 149 |
| 4.3.3 Bioregional floristic site-groups | 159 |
| 4.3.3.1 Bray-Curtis/UPGMA | 159 |
| 4.3.3.2 TWINSpan | 167 |
| 4.3.4 Relationships between vine thicket site-groups and bioclimatic attributes | 172 |
| 4.4 Discussion. | 180 |

Chapter 5. Local (Small-scale) Pattern in Vine Thicket and Associated Brigalow (*Acacia harpophylla*) Vegetation in Central Queensland

| | |
|--|------------|
| 5.1 Description of the study area. | 193 |
| 5.1.1 Climate | 193 |
| 5.1.2 Landform and soils | 195 |
| 5.2 Data collection. | 195 |
| 5.2.1 Vegetation data | 195 |
| 5.2.2 Environmental data | 196 |
| 5.2.2.1 Soil | 197 |
| 5.2.2.2 Topography | 197 |
| 5.2.2.3 Micro-relief | 197 |
| 5.2.2.4 Light | 198 |
| 5.3 Data analyses. | 198 |
| 5.4 Results. | 200 |
| 5.4.1 Vegetation classification | 200 |
| 5.4.2 Environmental classifications | 201 |
| 5.5 Description of vegetation groups. | 204 |
| 5.6 Environmental relationships. | 206 |
| 5.7 Discussion. | 208 |

Chapter 6. Temporal Patterns in Vine Thicket Communities with Particular Reference to Changes Recorded over 20-25 years in a *Macropteranthes leichhardtii* Stand and Associated Vine Thicket Vegetation in Central Queensland

| | |
|---|------------|
| 6.1 Methods. | 215 |
| 6.1.1 Re-measurement of Brigalow Research Station transect plots | 215 |
| 6.1.2 Recording of supplementary growth data for vine thicket tree species | 215 |
| 6.1.3 Collation of data on modes of regeneration and dispersal of vine thicket tree species | 216 |
| 6.2 Seasonal trends. | 216 |
| 6.3 Results from re-measurement of Brigalow transect plots. | 217 |
| 6.3.1 General trends across vegetation groups | 217 |
| 6.3.2 Changes within different vegetation groups | 220 |
| 6.3.3 Changes across boundaries between vegetation groups | 227 |
| 6.4 Results from measurement of growth of vine thicket tree species. | 233 |
| 6.5 Modes of regeneration and dispersal of vine thicket tree species. | 238 |
| 6.6 Discussion. | 239 |
| Chapter 7. General discussion and conclusions. | 245 |
| 7.1 Patterns in vine thickets of central and southern Queensland. | 246 |
| 7.1.1 Stand structure and site characteristics | 246 |
| 7.1.2 Species distribution and vegetation classification | 247 |
| 7.1.3 Relationships of communities with climate | 249 |
| 7.2 Large-scale patterns in vine thickets. | 249 |
| 7.3 Temporal changes in vine thickets. | 250 |
| 7.4 Interpretation and implications. | 251 |
| 7.5 Conclusions and recommendations. | 253 |
| References. | 256 |
| Appendices. | |

List of Tables

| Table | Page | |
|-------|---|----|
| 2.1 | Some mechanisms that could produce low diversity among canopy trees in tropical and subtropical rainforest (from Connell and Lowman 1989) | 38 |
| 3.1 | Subunits (provinces) within the Brigalow Belt and Southeast Queensland Biogeographic Regions (see Figure 3.1) | 47 |
| 3.2 | Mean and median monthly rainfall (mm) for six centres in the Brigalow Belt Biogeographic Region of central and southern Queensland | 53 |
| 3.3 | Incidence of drought for six centres in the Brigalow Belt Biogeographic Region of central and southern Queensland. | 53 |
| 3.4 | Trends in seasonal rainfall (mm) during 1987-93 for six centres in the Brigalow Belt Biogeographic Region of central and southern Queensland. | 54 |
| 3.5 | Mean monthly temperatures (maxima and minima) for six centres in the Brigalow Belt Biogeographic Region. | 55 |
| 3.6 | List of vine thicket sites, number of replicates and data collected from each subplot. | 58 |
| 3.7 | List of climatic attributes generated for vine thicket sites by BIOCLIM. | 64 |
| 3.8 | Semi-strong hybrid multidimensional scaling (SSH) - dimensions and corresponding stress values for ordinations with relative importance and cover data. | 69 |
| 3.9 | Summary of area, topography, slope, aspect and other site attributes for 142 vine thicket plots (75 sites). | 75 |
| 3.10 | Basal areas, stem densities and numbers of tree species for 142 vine thicket plots. | 80 |
| 3.11 | Numbers of stems in diameter classes and largest stems - vine thicket trees. | 83 |
| 3.12 | Vine thicket tree species with relative densities of 25% or greater. | 84 |
| 3.13 | Records of tree species with crown covers of 25% or greater in 133 vine thicket plots. | 85 |
| 3.14 | Vine thicket species occurring in 34 or more plots (i.e. a frequency of >25%). | 86 |
| 3.15 | Species counts, diversity and evenness measures for vine thicket plots. | 88 |
| 3.16 | Cumulative species and area totals (%) within 50 vine thicket subplots. | 92 |
| 3.17 | Species counts for replicate plots - species in common and comparisons with site totals. | 95 |

| | | |
|------|---|-----|
| 3.18 | List of classifications undertaken on vine thicket plot data. | 97 |
| 3.19 | Mean values for major species in vine thicket site-groups based on relative importance data (classifications An 2 and An 4 - <i>Brachychiton</i> spp. excluded). | 101 |
| 3.20 | List of plots in 9 site-groups based on classification (B-C/UPGMA) of species presence/absence data for 136 vine thicket plots. | 104 |
| 3.21 | List of plots in 12 preliminary site-groups based on classification (B-C/UPGMA) of tree and shrub cover data for 133 vine thicket plots (An 7). | 112 |
| 3.22 | Nearest-neighbours of (possibly) mis-classified vine thicket sites (based on cover data). | 112 |
| 3.23 | Revised group definitions for vine thicket site-groups (community-types), based on Bray-Curtis/UPGMA classification of standardised cover data (An 7). | 118 |
| 3.24 | Mean crown cover values (%) for tree and shrub species in 8 vine thicket site-groups (mean cover > 10% for one or more groups). | 118 |
| 3.25 | List of vine thicket tree and shrub species with frequency of >0.40 in 1 or more site-groups (excluding groups 2 and 7). | 119 |
| 3.26 | List of vine thicket sub-shrub and vine species with frequency of >0.35 in 1 or more site-groups (excluding groups 2 and 7). | 120 |
| 3.27 | Spearman rank order correlation coefficients between biomass and diversity measures for vine thicket sites and 16 climatic (BIOCLIM 2.0) attributes. | 133 |
| 3.28 | Number of species per 32 nearest-neighbours sample in south-eastern Queensland rainforests. | 140 |
| 4.1 | List of 160 vine thicket sites and their site-groups from 2 classifications based on species presence/absence data. | 145 |
| 4.2 | Composition of site-groups produced by 2 classifications of floristic data for 160 vine thicket sites in the Brigalow Belt Biogeographic Region of eastern Australia. | 151 |
| 4.3 | List of species recorded from 10 or more vine thicket sites in the Brigalow Belt Biogeographic Region. | 160 |
| 4.4 | Species with frequencies of 0.50 or greater in 10 site-groups produced by agglomerative classification of floristic data for 160 vine thicket sites. | 163 |
| 4.5 | Species with frequencies of 0.50 or greater in 11 site-groups produced by divisive (TWINSPAN) classification of floristic data for 160 vine thicket sites. | 169 |
| 4.6 | Analysis of variance - vine thicket groups (based on analyses of bioregional data) and 35 climatic (BIOCLIM) attributes | 172 |

| | | |
|------|--|-----|
| 4.7 | Correlations between BIOCLIM attributes, based on bioregional vine thicket floristic data. | 173 |
| 4.8 | Correlations (PATN-PCC and Spearman rank order correlation) between 35 BIOCLIM attributes and vector scores from ordinations of presence/absence data for 160 vine thicket sites. | 175 |
| 4.9 | Significance of differences between group means for 35 climatic attributes - groups based on species presence/absence data for Brigalow Belt Biogeographic Region (160 sites). | 183 |
| 4.10 | Comparison of site classifications from detailed survey and bioregional vine thicket databases. | 185 |
| 4.11 | Floristic subgroups within eastern Australian dry rainforests (after Nix <i>et al.</i> 1992). | 188 |
| 4.12 | Brigalow bioregional site-groups with most frequent species and mean values for major climatic attributes. | 190 |
| 5.1 | Mean monthly rainfall and temperature data for Brigalow Research Station (Brigalow RS) (1965-1990). | 195 |
| 5.2 | Mean and median monthly rainfall totals (mm) for the Bauhinia Downs - Moura district of central Queensland. | 195 |
| 5.3 | Environmental attributes recorded for plots 11-66, Brigalow Research Station permanent transect. | 199 |
| 5.4 | Comparison of site-groups produced by classification of vegetation and environmental data for Brigalow RS transect plots 11-66. | 201 |
| 5.5 | Mean importance value indices for tree and shrub species (>2.5 cm dbh) - Brigalow RS transect plots 11-66. | 205 |
| 5.6 | Correlations between 11 environmental attributes and vector scores from ordinations of vegetation data for Brigalow RS transect plots 11-66. | 206 |
| 5.7 | Analysis of variance and comparison of group means for 11 environmental attributes - vegetation groups based on importance value indices for tree and shrub species in Brigalow RS transect plots 11-66. | 207 |
| 5.8 | Comparison of records of vine thicket trees along Brigalow RS transect using quadrat (20m X 20m) and plotless sampling. | 210 |
| 6.1 | Monthly rainfall at Brigalow Research Station (1966-1990), expressed as proportions of (monthly) median values. | 217 |
| 6.2 | Comparison of numbers and sizes of stems of seven vine thicket species in Brigalow RS transect plots 18-21 (group 6) measured in 1968/70 and in 1990/92. | 222 |

| | | |
|-----|---|-----|
| 6.4 | Comparison of stem counts for 7 vine thicket species in Brigalow RS plots 12-14 measured in 1968/70 and in 1990/92. | 230 |
| 6.5 | Comparison of stem counts for 8 vine thicket species in Brigalow RS plots 58-61 measured in 1968/70 and in 1990/92. | 232 |
| 6.6 | Growth (per annum increment - PAI) of vine thicket tree species at Brigalow Research Station from 1968 to 1992. | 233 |
| 6.7 | Growth (per annum increment - PAI) of vine thicket tree species over 11 years (1984-1995) at Yarraman, south-east Queensland. | 237 |
| 6.8 | Counts of resprouting vine thicket species following clearing and burning at Brigalow Research Station. | 243 |

LIST OF FIGURES

| Figure | | Page |
|--------|---|------|
| 2.1 | Distribution of floristic regions and provinces of Australian rainforests (after Webb and Tracey 1994). | 18 |
| 2.2 | Structural changes in rainforest along different environmental gradients (after Webb 1968). | 20 |
| 2.3 | Schematic representation of secondary succession and natural regeneration in rainforest showing some of the variations that occur in relation to intensity of disturbance (after Hopkins 1981). | 36 |
| 3.1 | Map of Brigalow Belt Biogeographic Region, showing locations of major centres and climate stations (see Table 3.2). | 48 |
| 3.2 | Subunits (provinces) of the Brigalow Belt Biogeographic Region and adjacent areas of Southeast Queensland (see Table 3.1). | 49 |
| 3.3 | Survey of remnant vine thicket communities in central and southern Queensland - location of detailed sites and biogeographic provinces (see Figure 3.2) | 57 |
| 3.4 | Design of plotless sample (32 nearest-neighbours) - vine thicket survey.. | 60 |
| 3.5 | Regression relationship for adjustment of areas of plotless samples, based on data from araucarian vine forest sites in the Mary River Valley. | 61 |
| 3.6 | SSH ordinations (semi-strong-hybrid multidimensional scaling) - stress values and numbers of dimensions (see also Table 3.8). | 69 |
| 3.7 | Histogram of species frequency based on cover data from 133 vine thicket plots (number of species \times frequency class). | 86 |
| 3.8 | Species/area relationships for replicate plots from 9 sites (22, 28, 30, 34, 49, 55, 57, 60 and 62), representing a range of vine thicket community-types. | 94 |
| 3.9 | Distribution of vine thicket site-groups in central and southern Queensland, based on classification of species abundance data. | 98 |
| 3.10 | Distribution of vine thicket site-groups in central and southern Queensland, based on classification of species presence/absence data. | 99 |
| 3.11 | Ordination (DCA and SSR) of 136 vine thicket plots. Symbols show site-groups based on classification (Bray-Curtis/UPGMA clustering) of presence/absence data. | 105 |
| 3.12 | Ordination (DCA) of 136 vine thicket plots. Symbols show site-groups based on divisive (TWINSPAN) and agglomerative (B-C/UPGMA clustering) classifications of presence/absence data. | 108 |

| | | |
|------|---|-----|
| 3.13 | Ordination (DCA) of 211 vine thicket species (trees, shrubs and vine). Symbols indicatespecies-groups based on classification (Two-Step/UPGMA clustering) of presence/absence data. | 109 |
| 3.14 | Ordination (DCA and SSR) of 133 vine thicket plots. Symbols show site-groups based on classification (B-C/UPGMA clustering) of cover data for tree and shrub species. | 113 |
| 3.15 | Modified classification of vine thicket plots based on standardised cover class data and Bray-Curtis coefficient with UPGMA clustering. | 116 |
| 3.16 | Distribution of vine thicket site-groups in central and southern Queensland. Groups based on classification (B-C/UPGMA clustering) of standardised cover data for tree and shrub species. | 117 |
| 3.17 | Means, medians and ranges of values of 10 climatic attributes (BIOCLIM 2.0) for vine site-groups based on classification (B-C/UPGMA clustering) of cover data. | 134 |
| 4.1 | Classification of 160 vine thicket sites within the Brigalow Belt Biogeographic Region, based on species presence/absence data and Bray-Curtis coefficient with UPGMA clustering. | 150 |
| 4.2 | Distribution of 10 vine thicket community-types within the Brigalow Belt Biogeographic Region. Types based on agglomerative classification (B-C/UPGMA clustering) of presence/absence data for trees, shrubs and vines. | 152 |
| 4.3 | Ordination (DCA and SSR) of 160 vine thicket plots. Symbols show site-groups based on agglomerative classification (B-C/UPGMA) of presence/absence data. | 153 |
| 4.4 | Divisive (TWINSPAN) classification of 160 vine thicket sites within the Brigalow Belt Biogeographic Region, based on species presence/absence data for trees, shrubs and vines. | 155 |
| 4.5 | Distribution of 11 vine thicket community-types within the Brigalow Belt Biogeographic Region. Types based on divisive (TWINSPAN) classification of presence/absence data for trees, shrubs and vines. | 156 |
| 4.6 | Ordination (DCA) of 291 vine thicket species (trees, shrubs and vines). Symbols indicate species-groups based on classification (Two-Step/UPGMA clustering) of presence/absence data. | 157 |
| 4.7 | Ordination (DCA) of 160 vine thicket plots. Comparison of site-groups based on divisive (TWINSPAN) and agglomerative (B-C/UPGMA) classifications of species presence/absence data. | 168 |
| 4.8 | Comparison of DCA ordination of bioregional vine thicket community-types (based on species presence/absence data) and vector directions of 35 climatic (BIOCLIM) attributes. | 176 |

| | | |
|------|---|-----|
| 4.9 | Comparison of SSR ordination of bioregional vine thicket community-types (based on species presence/absence data) and vector directions of 35 climatic (BIOCLIM) attributes. | 178 |
| 4.10 | Means, medians and ranges of values of 18 climatic attributes for bioregional vine thicket community-types based on classification (B-C/UPGMA clustering) of species presence/absence data. | 181 |
| 4.11 | Variation in annual rainfall at “Banana”, Moura district, central Queensland, 1872-1992. | 191 |
| 5.1 | Schematic diagram of Brigalow Research Station permanent transect (plots 11-66), showing vegetation groups and major site attributes. | 194 |
| 5.2 | Classification of Brigalow Research Station transect plots 11-66 based on importance values and Bray-Curtis coefficient with UPGMA clustering. | 202 |
| 5.3 | Ordination (DCA and SSR) of Brigalow Research Station transect plots 11-66. Symbols show site-groups based on classification (B-C/UPGMA clustering) of importance data. | 203 |
| 6.1 | Comparison of total stem counts in Brigalow RS transect plots 18-21 (group 6) and 37-40 (group 5) in 1968-70 and in 1990-92. | 220 |
| 6.2 | Comparison of stem counts in Brigalow RS plots 18-21 (group 6) measured in 1968-70 and in 1990-92. | 223 |
| 6.3 | Comparison of stem counts in Brigalow RS plots 37-40 (group 5) measured in 1968-70 and in 1990-92. | 225 |
| 6.4 | Comparison of total stem counts for vine thicket species in Brigalow RS plots 12-14 measured in 1968-70 and in 1990-92. | 229 |
| 6.5 | Comparison of total stem counts for vine thicket species in Brigalow RS plots 58-61 measured in 1968-70 and in 1990-92. | 231 |
| 6.6 | Growth models for 6 vine thicket tree species based on data from Brigalow RS transect measured in 1968-70 and in 1990-92. | 235 |

List of Photographs

Plate

- 1 Upper Walker Creek valley, showing extensive areas of vine thicket (type 4), dominated by *Backhousia angustifolia*, on western slopes of Bunya Mountains. Narrow-leaved bottle-tree (*Brachychiton rupestris*) in foreground.
- 2 Vine thicket (type 5) with emergent ooline (*Cadellia pentastylis*) and bottle-tree (*Brachychiton rupestris*), Bullaroo Creek, Carnarvon National Park, between Injune and Rolleston (site 37).
- 3 Hurdle Gully (Scientific Area 33), Coomingleh State Forest, west of Monto (sites 69, 70). This large area of vine thicket (c. 700 ha) has numerous emergent *Flindersia australis* and *Brachychiton* spp..
- 4 Interior of vine thicket/forest (type 1), Coomingleh State Forest (site 70). Note relatively tall, open structure. Trees include *Cupaniopsis parvifolia*, *Brachychiton australis* and *Flindersia australis*.
- 5 Interior of vine thicket (type 1), Callide Range, north-east of Biloela (site 68). Species include *Austromyrtus bidwillii*, *Strychnos axillaris* and *Melicope erythrococca*. Note abundant woody vines.
- 6 Eastern slopes of Mt Larcom, north of Gladstone. Vine thicket (type 3) on mixed volcanics. Note abrupt boundary with eucalypt woodland.
- 7 Vine thicket (type 3), Goodedulla National Park, west of Rockhampton (site 73). Note browning and loss of foliage due to extreme drought conditions (August 1994). Species include *Backhousia kingii*, *Croton insularis*, *Owenia venosa*, *Geijera paniculata* and *Acalypha eremorum* (foreground).
- 8 Interior of (type 3) vine thicket, "Cerberus", west of Marlborough (site 67). Species include *Backhousia kingii*, *Excoecaria dallachyana*, *Guettardella putaminosa* and *Planchonella cotinifolia* var. *pubescens*.
- 9 Vine thicket (type 5) with large emergent ooline (*Cadellia pentastylis*) and broad-leaved bottle-tree (*Brachychiton australis*), "Bimbadeen", Taroom (site 61).
- 10 Vine thicket (type 8) with emergent brigalow (*Acacia harpophylla*), upper Zamia Creek, Palmgrove National Park, north-west of Taroom (site 52).
- 11 Vine thicket remnant, "Stuart Downs", Wandoan (type 5). Species include *Acacia fasciculifera*, *Geijera parviflora*, *Ehretia membranifolia*, *Flindersia collina* and *Planchonella cotinifolia* var. *pubescens*.

- 12 Cleared vine thicket (type 6), Nebo district. Note effects of recurrent fires on hillslopes.
- 13 Vine thicket (type 6) on low hillslopes, "Blenheim", north of Nebo (site 47).
- 14 Interior of (type 6) vine thicket, "Blenheim", north of Nebo (site 47). Note rocky substrate. Shrub layer dominated by *Abutilon tubulosum* and *Acalypha eremorum*.
- 15 Vine thicket (type 8) dominated by bonewood (*Macropteranthes leichhardtii*), "Bonnie Doon", south-east of Emerald (site 43). *Lysiphyllum hookeri* in foreground.
- 16 Interior of vine thicket (type 8) dominated by bonewood (*Macropteranthes leichhardtii*), Brigalow Research Station, Theodore. Narrow-leaved bottle-tree (*Brachychiton rupestris*) prominent.
- 17 Mingela Bluff, south-west of Townsville, showing vine thicket on midslopes (site 48).
- 18 Remnant vine thicket (regional type 9) on hillslopes, 16km west of Gunnedah, NSW.

List of Appendices

| Appendix | | Page |
|-----------------|---|-------------|
| 1 | Field key to structural types of Australian rainforest vegetation (after Webb 1978a). | <i>A1</i> |
| 2 | List of plant species recorded in vine thicket communities in the Brigalow Belt Biogeographic Region. | <i>A4</i> |
| 3 | Locality data for 160 vine thicket sites in the Brigalow Belt Biogeographic Region. | <i>A13</i> |
| 4 | Table of geological substrates for 160 vine thicket sites in the Brigalow Belt Biogeographic Region (determined from 1:250 000 map series). | <i>A18</i> |
| 5 | Table of climatic (BIOCLIM) attribute values for 160 vine thicket sites in the Brigalow Belt Biogeographic Region. | <i>A24</i> |
| 6 | Comparison of bioregional vine thicket group means and standard deviations for 35 BIOCLIM attributes. Groups derived from presence/absence data for 160 vine thicket sites. | <i>A32</i> |
| 7 | Regenerative and other attributes of vine thicket tree species. | <i>A33</i> |
| 8 | List of frugivorous birds recorded in central and southern Queensland vine thickets. | <i>A39</i> |
| 9 | Growth data (basal areas) for individual vine thicket trees - Brigalow Research Station transect. | <i>A40</i> |