Plate 13. Vine thicket (type 6) on low hillslopes, "Blenheim", north of Nebo (site 47).

Plate 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*.

CHAPTER SEVEN

GENERAL DISCUSSION AND CONCLUSIONS

In this chapter, I return to the objectives and questions stated at the conclusion of **Chapter 2** of this thesis. The major objective of this study was to explore floristic patterns in semi-evergreen vine thicket vegetation, with particular emphasis on the major remnants of this community which are found mainly in the Fitzroy and Burnett River catchments of central and southern Queensland. The following questions were asked: **Are there broad-scale patterns of species distribution and abundance in these communities? If so, how are these related to climatic and other environmental factors? How robust are these patterns and relationships when applied over a broader region, i.e. the Brigalow Belt Biogeographic Region? How do these patterns and relationships conform with contemporary community concepts and relationships within Australian dry rainforests?**

The first question formed the main theme of **Chapter 3**, addressed through the collection and analysis of data from 75 vine thicket stands in central and southern Queensland. **Chapter 4** examined species patterns and climatic relationships within an expanded regional context of 160 stands throughout the Brigalow Belt Biogeographic Region and related these to the results of other regional studies in Australian vine thickets.

The second objective of my study was to examine large-scale spatial and temporal patterns within an area of *Macropteranthes leichhardtii* - dominated vine thicket in central Queensland. The following questions were asked: **What local-scale patterns of species distribution and abundance occur within vine thicket and associated brigalow (*Acacia harpophylla*) - dominated vegetation? How are these patterns related to site factors? What temporal changes can be identified in these communities, i.e. what changes in species abundance have taken place since establishment of the transect? Can these changes be related to currently-accepted models of succession in rainforest vegetation?** These questions were addressed in **Chapters 5** and **6**, using data collected from a permanent vegetation transect established at Brigalow Research Station by Johnson (1980).

7.1 Patterns in vine thickets of central and southern Queensland.

Three aspects of vine thicket pattern are addressed in this discussion; stand structure and site characteristics, species distribution and vegetation classification and relationships of communities with climate.

7.1.1 Stand structure and site characteristics.

Vine thicket communities in central and southern Queensland showed a considerable range of canopy height, cover and evenness. Structure varied from virtually closed stands in subcoastal areas to relatively open communities in more inland areas. In the inland vine thickets (community-type 8) which had occasional emergent *Acacia harpophylla*, it was difficult to define a point at which these stands should cease to be regarded as vine thickets for the purposes of this study.

In north-eastern areas, e.g. Marlborough and Nebo districts, deciduous species were prominent, but it was difficult to make clear distinctions between deciduous vine thicket and semi-evergreen vine thicket. Both Russell-Smith (1991) and Fensham (1995) expressed dissatisfaction with this particular aspect of the structural-physiognomic classification of Webb (1978) (see **Appendix 1**). The degree of deciduousness used to distinguish between vine thicket types is not adequately defined by Webb (Russell-Smith 1991), and emergents in this study area range from fully deciduous (e.g. *Brachychiton australis*) to semi-evergreen (e.g. *Brachychiton rupestris*). Additionally, many of the lower canopy species may shed their leaves to some extent, including *Diospyros humilis, Drypetes deplanchei, Notelaea microcarpa, Macropteranthes leichhardtii* and *Strychnos axillaris* (Fensham 1995).

Leaf sizes also show great variation, ranging from notophylls and even mesophylls (e.g. the deciduous species *B. australis* and *Gyrocarpus americanus*) to microphylls and nanophylls (e.g. *Canthium vacciniifolium*). There is frequently a variety of leaf sizes in individual vine thicket stands.

The degree of stratification of these communities is frequently simplified to a single tree layer in more inland areas, whereas in subcoastal areas a stand may comprise three tree layers (including emergents) and two shrubs layers. The diversity of climbing plants also decreases, ranging from large woody lianes in moister areas to slender ephemerals (e.g. *Passiflora aurantia*) and others which die back to perennial rootstocks, e.g. *Cissus opaca.*

The ground layer is often very sparse and grasses, apart from *Ancistrachne uncinulata*, are seldom prominent. Presence and abundance of other species is heavily dependent upon seasonal conditions, but common herbs include the ferns *Cheilanthes* and *Pellaea* spp. and species of Acanthaceae, e.g. *Pseuderanthemum* spp. and *Brunoniella australis.*

Spinescent and/or thorny species are most prominent in the shrub and low tree layers, e.g. *Acalypha* spp., *Citriobatus* spp., *Bursaria incana.* The most frequent vine thicket species was *Carissa ovata*, a thorny clonal shrub which may become a scrambling climber in eastern vine thickets.

Vine thickets occur on clays, clay loams and earths derived from a range of parent materials including basic volcanics, fine-grained sediments and intermediate volcanics and metasediments. They generally are found on more elevated, freely drained sites, often with *Acacia harpophylla* on adjacent downslope positions. Many sites have areas of loose rock, which have protected them both from fire and clearing. Most vine thickets on moderate slopes have been cleared for the establishment of pasture and these would have incuded many vine thicket occurrences on footslopes and flats, e.g. the Blenheim Creek valley north of Nebo. Very few *Macropteranthes leichhardtii* stands remain on Tertiary land surfaces, e.g. Brigalow Research Station and "Wallalee" near Springsure.

7.1.2 Species distribution and vegetation classification.

Vine thicket communities in south-eastern Queensland are relatively species-rich, and the diversity of canopy species approaches or may exceed that of many of the moister notophyll vine forest communities (see **Chapter 3**). They become increasingly species-poor as rainfall decreases and/or becomes more seasonal.

Ordination of the tree, shrub and climber species recorded during the survey identified 5 main groups of vine thicket species. The largest ("core") group, occupying a central position in ordination space (see **Figure 3.13**), included most of the most widespread and frequent species. The second group comprised the more inland species, including *Ventilago viminalis, Macropteranthes leichhardtii* and *Cadellia pentastylis*. The other three groups comprised a northern element (*Lysiphyllum hookeri, Gyrocarpus americanus*), a south-eastern element (species shared with the araucarian vine forests) and species confined to or particularly characteristic of the vine thickets of central Queensland. These patterns were confirmed by ordination of the expanded bioregional dataset (see **Chapter 4**).

The vine thickets of eastern Australia, and central and south-eastern Queensland in particular, are thus shown to comprise a floristic continuum, within which a series of geographical groups can be distinguished, corresponding to units termed "domains" (Bale and Williams 1993) or "provinces" (Webb *et al.* 1984). The composition and arrangement in the classificatory hierarchy of the site-groups (community-types) vary slightly among the different data sets (detailed survey and bioregional), but there is relatively close agreement otherwise. There are few sharp disjunctions between the floristic site-groups in ordination space, with groups frequently including outliers, and the various data arrays are correlated with a range of climatic attributes (**Chapter 4**). Fensham (1995) similarly recognised a series of intergrading but relatively discrete community-types among the vine thickets of northern inland Queensland, although these were derived by a divisive rather than an agglomerative procedure.

Six vine thicket suballiances (*sensu* Floyd 1991) are recognised in central and southern Queensland (see **Chapter 3**):

1. *Austromyrtus bidwillii - Owenia venosa - Excoecaria dallachyana* suballiance (community-type 1 - South-east Queensland)
2. *Strychnos axillaris - Archidendropsis thozetiana - Planchonella cotinifolia var. pubescens - Backhousia kingii* suballiance (community-type 3 - Central Queensland)
3. *Notelaea microcarpa - Geijera salicifolia* var. *salicifolia - Planchonella cotinifolia* var. *pubescens - Backhousia angustifolia* suballiance (community-type 4 - Auburn district)
4. *Planchonella cotinifolia* var. *pubescens - Geijera parviflora - Croton insularis - Acacia fasciculifera* suballiance (community-type 5 - upper Dawson Valley)
5. *Lysiphyllum hookeri - Terminalia oblongata - Planchonella cotinifolia* var. *pubescens* suballiance (community-type 6 - Nebo district)

6. *Macropteranthes leichhardtii - Ehretia membranifolia - Geijera parviflora - Croton insularis* suballiance (community-type 8 - Central Highlands).

Additional subgroups have been identified within suballiances 4 and 6 and confirmed on the basis of the bioregional analyses. Suballiance 4 can be divided into a group of more closed, species-rich stands, and one of more open stands, several of which are dominated by *Cadellia pentastylis.* Two groups may also be distinguished within the *Macropteranthes leichhardtii*-dominated communities; the drier, simpler stands in the Springsure district and the more complex and diverse stands in eatsern localities, e.g. Palmgrove National Park.

7.1.3 Relationships of communities with climate.

The communities recognised in this study have distinct geographical distributions and are thus closely correlated with the climatic attributes generated for the sites by BIOCLIM (see **Chapter 4**). Two of the most significant attributes associated with differences between community-types included coefficient of variation of annual rainfall (attribute 15) and mean temperature of coldest quarter (attribute 11). These attributes have also been identified as significant by Fensham (1995) (northern Queensland) and Neyland and Brown (1993) (eastern Tasmania).

Species diversity in vine thickets decreases both with decreasing rainfall and/or increasing seasonality. Thus there are declines both from east to west and from south to north. In the Nebo district, for example, the seasonal drought is exacerbated by the relatively high temperatures recorded during spring and summer.

7.2 Large-scale patterns in vine thickets.

The concept of a vine thicket continuum (see above) applies also at the local scale; for example at Brigalow Research Station (see **Chapter 5**). Whilst quite different communities occupy the low-lying heavy clays and elevated gradational soils, these intergrade through areas of brigalow/vine thicket on soils of intermediate texture and depth of A horizon (**Figure 5.1**). Just as different species have different climatic optima across a region, at the local level many have site optima. Hopkins (1975) commented on altitudinal and substrate preferences among canopy species in the CNVF communities of Lamington National Park

The major form of large-scale pattern in moister rainforest communities is associated with disturbance - the regeneration mosaic (see below). Areas of fallen trees occurred along the Brigalow Research Station transect but no species groupings were detected which might represent areas of secondary growth. Many dry forest species have a patchy distribution (see **Chapter 2**) and clumping was apparent in the distribution of some of the more uncommon tree species, eg. *Cassia tomentella, Atalaya salicifolia, Owenia venosa.* This could be attributed to the tendency of these species to reproduce by root suckers (see below). *Ehretia membranifolia* is often clumped, and an extreme example of this pattern (both small- and large-scale) is provided by *Macropteranthes leichhardtii.*

7.3 Temporal changes in vine thickets.

Changes recorded over the 20-25 years in both vine thicket and brigalow/vine thicket communities have been discussed above (**Chapter 6**). Numbers of species increased overall and numbers of stems (>2.5cm dbh) have increased - this increase has apparently come from class 1 stems (>30cm high, <2.5cm dbh) present in 1968-70. Numbers of class 1 stems of most species were lower in 1990-92, except for *Canthium vacciniifolium*, *Croton insularis* and *Geijera parviflora* in the brigalow/vine thicket community.

Decreases in stem densities were recorded for *Acacia harpophylla*, *Acalypha eremorum*, *Croton phebalioides* and *Opuntia tomentosa*. *Croton phebalioides* died out in that section of the transect and *Opuntia tomentosa* had also suffered considerable mortality.

Contrasting strategies such as the distinction between pioneer and non-pioneer species are not readily apparent in vine thicket communities. Hopkins *et al.* (1990) have noted the absence of a seed bank of pioneer tree and shrubs species in vine thicket at Forty Mile Scrub compared with the moister tropical rainforests. Species such as *Polyscias elegans* and *Alphitonia excelsa* which occur as pioneer/early secondary species in CNVF also occur in many vine thickets. One species noted in **Chapter 6**, *Codonocarpus attenuatus,* behaves as a pioneer species, especially in areas subjected to fire Some species such as *Croton insularis* and *C. phebalioides* appear to be more abundant in the more open vine thickets and are comparatively short-lived. *C. insularis* is a common component of disturbed ANVF communities.

7.4 Interpretation and implications.

Hopkins (1975, 1981, 1991) has discussed the processes involved in maintaining the high (α-) diversity of canopy species in the moist rainforests of tropical and subtropical Queensland (see **Chapter 2**). Species are dependent for regeneration upon the creation of light gaps and species have evolved a range of strategies to utilise these opportunities. Two broad groups or "guilds" are recognised; the pioneer or early secondary species and the non-pioneer or climax species. The nature of the regenerating community depends on the intensity, size and extent of disturbance. In the larger gaps, regeneration of canopy (non-pioneer) species is dependent upon dispersal of seed into the area.

In vine thickets and other dry seasonal communities, the major limiting resource is moisture rather than light, and vine thicket species have developed a variety of adaptations to cope with water stress during the prolonged dry season. These include a deciduous habit (both obligate and facultative), use of trunk as water-storage organ (*Brachychiton* spp,) and the ability to withstand low xylem water potentials (e.g. *Acacia aulacocarpa* in SEVT compared with moister rainforest types in north Queensland (Unwin and Kriedemann 1990). There is a need for comparative physiological studies on a range of vine thicket tree species.

A common feature of species in these communities is the ability to regenerate through vegetative means such as the production of basal sprouts and shoots from lateral roots. *Macropteranthes leichhardtii*, for example, in addition to resprouting from the base, regenerates through the layering of branches. *Backhousia* spp. also regenerate by this means and Benson (1995) concluded that an even-aged stand of *Cadellia pentastylis* had been produced by root-suckering.

Dunlop and Webb (1991) viewed vegetative regeneration in monsoon species as an alternative to seedling regeneration under conditions of annual drought and excessive competition during the establishment phase. It provides these species with a competitive advantage because of their ability to recover relatively rapidly once seasonal conditions have improved, in contrast to plants which have to grow back from seed. Many canopy species in the drier vine thickets have wind-dispersed fruit and although this is not as efficient as dispersal by animal vectors, any disadvantage appears to be offset by the competitive ability of these plants once established. *Macropteranthes leichhardtii* dominates most vine thicket stands in the Central Highlands (community-type 8), while *Backhousia angustifolia* and *B. kingii* often comprise more than 50% of the stands in which they occur (see **Chapter 3**).

In the more mesic vine thickets, domination by for example *Backhousia kingii* could perhaps represent a form of truncated succession (*sensu* Webb and Tracey 1981), of relatively temporary duration. *Macropteranthes leichhardtii*, however, occurs over large areas at the drier extreme of vine thicket distribution and perhaps this community represents the end-point of climatic-edaphic sifting of the type discussed by Webb and Tracey (1981) and earlier by Herbert (1960). In one stand at the eastern edge of its distribution, this species was recorded in a relatively diverse vine thicket community (S018) (community-type 5). *M. leichhardtii* was present as a single large stem, but it was not possible to determine whether in fact this species had been more common in this locality in the recent past.

This situation is comparable with some of the occurrences of *Macropteranthes leiocaulis* on the Boomer Range, for example. *Backhousia angustifolia* appears to act as a secondary species in some communities, and is relatively resistant to fire. It is common in open sites such as patchy areas of vine thicket species in grassy eucalypt woodland on basalt as well as forming a major canopy species in vine thickets in these localities (e.g. Walker Creek (S066) and Ka Ka Mundi).

In seeking to apply the results of the transect studies at Brigalow Research Station, one has to ask how representative the past 20 years have been in terms of rainfall and other climatic factors. Although mean and median rainfall values over this period have been similar to longer-term averages for nearby centres (see **Table 5.2**), patterns have been quite variable (**see Table 6.1**). There was a series of years of above-average rainfalls during the 1970s and early 1980s, followed by several years in which the summer rains failed, but above-average winter rains occurred, and in the latter part of this period, both summer and winter rains were well below average (**Table 6.1**). Longer-term rainfall records, for "Banana" for example, show alternating periods of above- and below-average annual rainfall, each period extending over several years, but interrupted by an occasional dry or wet year respectively (see **Figure 5.7**). There has been a general trend through much of eastern Australia of above-average rainfall from the late 1940s to mid 1970s (Clewett *et al.* 1994).

Webb and Tracey (1981) regarded most of the occurrences of monsoon forest in northern Australia as relictual, but Russell-Smith (1991) drew attention to communities on Holocene landforms in the Northern Territory, while Fensham(1995) also has argued that vine thicket communities in northern inland Queensland have developed in the relatively recent past. Pollen and charcoal records from north-eastern Queensland suggest that extremely dry conditions prevailed up until 8000 years ago (Kershaw 1985, Hopkins *et al.* 1993). In the Lockyer Valley of south-eastern Queensland, there is evidence of a renewed cycle of cutting-down in the Brisbane River and its tributaries about 3000 years ago (Smith *et al.* 1990), indicating a significant relative increase in rainfall. This might partly explain why there has been an apparent recent movement of vine thicket species into brigalow communities where soils are suitable.

7.7 Conclusions and recommendations.

The species patterns in the vine thickets of central and southern Queensland are the product of a complex series of environmental and biological processes. Climatic sifting has produced both north-south and east-west patterns and at the driest extreme in central Queensland has resulted in communities dominated by the endemic species *Macropteranthes leichhardtii* and the disjunct endemic *Cadellia pentastylis*. During periods of higher than average rainfall and at the eastern margin of the Brigalow Belt species from more mesic communities are dispersed into and establish in vine thickets and associated brigalow communities in a form of directed succession.

Although deliberately omittted from the present study, locally favourable sites associated with watercourses are extremely significant when considering longer-term processes in vine thicket communities. They provide a refugial niche for species which are otherwise found in more mesic communities nearer the coast, for example, *Excoecaria dallachyana* persisting in shallow drainage line at Brigalow Research Station and near Taroom. They also provide opportunities for establishment of other, bird-dispersed species (e.g. *Cissus* spp., *Ficus* spp.), which may then act as a source for further dispersal.

In the absence of major disturbances such as storm damage and or fire, extant areas of vine thicket would be expected to diversify and expand until interrupted by a new cycle of relatively dry conditions. The clearance in recent years of extensive areas of vine thicket and brigalow for grazing and cropping has severely disrupted many of these patterns and processes across the Brigalow Belt.

The preliminary results reported from the Brigalow Research Station transect demonstrate the value of long-term monitoring experiments based on quantitative data. It would be desirable to tag individuals of a range of species to gain more accurate data on rates of growth as well as mortality and recruitment. This would have made the data for *Macropteranthes leichhardtii* more useful - it is impossible to re-locate individual stems of the more abundant species unless they have been tagged. The value of this is apparent in the results from Yarraman State Forest (**Chapter 6**). It is important that other permanent reference sites be established in vine thickets and other seasonal rainforest communities, and that existing plots be maintained (by replacement of pegs, renewal of fencing and maintenance of access tracks).

There is also a need to set up exclosures to determine the extent of grazing/browsing by macropods and to what degree this could be affecting regeneration of the vine thicket species. The large numbers of wallabies sheltering in the Brigalow Research Station transect and in other vine thicket remnants are a threat to the long-term viability of these areas, as well as causing considerable losses in the surrounding crops and crops and pastures. Many landholders see removal of shelter as their only solution to this problem at present, but others wish to protect their remnant vegetation, and practical methods of management of macropod numbers are being sought urgently, e.g. in the Injune district.

The south-eastern vine thickets (suballiances 1 and 3) are the most diverse and provide habitat for both threatened plants (e.g. *Denhamia parvifolia*) and wildlife (e.g. black-breasted button quail). Most of these communities have now been cleared and it is vital that remaining areas be protected through nature conservation reserves and most importantly through the negotiation of voluntary nature conservation agreements with private landholders. This has already occurred in the case of Berlin Scrub Nature Refuge in the Lockyer valley (S074).

Introduced plant species are becoming an increasing challenge for the managers of remnant vine thickets and other dry rainforests. Madeira vine (*Anredera cordifolia*) and climbing asparagus (*Asparagus africanus*) are now a severe problem in the Lockyer and Fassifern districts, and rubber vine (*Cryptostegia grandiflora*) is present on vine thicket margins in central and northern inland Queensland. *Lantana camara* and *Rivina humilis* are becoming more abundant in the moister subcoastal vine thickets. *Opuntia tomentosa* was the most widespread alien tree or shrub species recorded during the vine thicket survey (see **Chapter 3**), but dense populations are relatively localised and appear to be short-lived (see **Chapter 6**).

The most serious immediate problems are associated with the introduced pasture species sown into cleared and burnt vine thicket and brigalow communities, prticularly *Cenchrus ciliaris* and *Panicum maximum* var. *trichoglume* (see **Chapter 3**). They provide fuel for fires which then impact on the boundaries of remnants, e.g. along the northern slopes of the Carnarvon Range. *Panicum maximum* and to a lesser degree *Cenchrus ciliaris* have also spread into these communities which are more open and susceptible to invasion than the moister rainforests. More effective management of both fire and grazing are required in these areas.

Plate 15. Vine thicket (type 8) dominated by bonewood (*Macropteranthes leichhardtii*), "Bonnie Doon", south-east of Emerald (site 43). *Lysiphyllum hookeri* in foreground.

Plate 16. Interior of vine thicket (type 8) dominated by bonewood (*Macropteranthes leichhardtii*), Brigalow Research Station, Theodore. Narrow-leaved bottle-tree (*Brachychiton rupestris*) prominent.