Plate 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.

Plate 6. Eastern slopes of Mt Larcom, north of Gladstone. Vine thicket (type 3) on mixed volcanics. Note abrupt boundary with eucalypt woodland.

CHAPTER THREE

A SURVEY AND CLASSIFICATION OF REMNANT SEMI-EVERGREEN VINE THICKET STANDS IN CENTRAL AND SOUTHERN QUEENSLAND

Semi-evergreen vine thicket communities are estimated to have occurred over several hundred thousand hectares in central and southern Queensland (Webb and Tracey 1981). Conservation of the remnants depends upon an understanding of species and community patterns, but there has been relatively little systematic collection of data from these communities. A considerable area of central Queensland was surveyed by CSIRO land resource teams between 1962 and 1964, but much of the vegetation data collected concerned mainly dominant species. In a report integrating the results of the Fitzroy surveys (Gunn and Nix 1977), Nix (1977) recognised three groups of vine thicket communities occupying different substrates:

(i) vine thickets on relatively fresh rock material, principally Mesozoic shales and other labile sediments
(ii) those on deeply weathered basalt and secondary carbonates (typically dominated by *Macropteranthes leichhardtii*) and
(iii) vine thickets on deeply weathered sediments (often with emergent *Cadellia pentastylis*).

Webb, Tracey and Williams (1984) based their floristic analysis of Australian rainforests on presence/absence data for tree and shrub species at 561 sites. Their data set included 40 semi-evergreen vine thicket (SEVT) sites, of which 15 and 25 were classified into their C_1 and C_2 floristic provinces respectively (see **Figure 2.1**, section **2.2.2.1**). The core area of their C_2 province is a group of vine thicket sites between Boonah and Biloela in south-eastern Queensland, which occur mainly on soils derived from basic igneous rocks or calcareous sediments.

Although the data set included outliers as far west as Morven, major areas of vine thicket in the Central Highlands were not sampled, largely because of their inaccessibility (Webb *et al.* 1984). These included the Springsure district, the Expedition and Bigge Ranges and the Boomer Range.

Beadle (1981) recognised a series of alliances within the vine thicket communities of central and northern inland Queensland. Included among Beadle's alliances, which were based on relatively limited field data, are *Cadellia pentastylis*, *Brachychiton* spp. and *Macropteranthes* spp. alliances. One of the aims of the present study is to test the validity of these vegetation units.

Floyd (1991) has classified the rainforests of New South Wales into a series of alliances and suballiances, based on estimated abundance and frequency of canopy species. Vine thicket communities comprise one of four alliances within the dry rainforest formation. The vine thicket alliance includes two suballiances, *Alectryon forsythii - A. subdentatus - Notelaea microcarpa* in steep gorges in north-eastern New South Wales and *Notelaea microcarpa - Ehretia membranifolia - Geijera parviflora* on the north-western slopes. Floristic data from several localities cited by Floyd (1991) in his description of the latter suballiance have been included in the bioregional floristic analysis in **Chapter 4** below.

Only a small amount of quantitative data is available on stand composition of eastern Australian vine thickets, namely the results of the transect study established by Johnson (1980) at Theodore (see **Chapter 5**), and plots surveyed in the upper Hunter valley by Turner (1976b).

Murphy and Lugo (1987a) noted a general trend of decreasing structural and floristic diversity in dry seasonal forests as moisture regimes become increasingly limiting. Webb (1968) has illustrated the relationships between Australian rainforest structure and decreasing rainfall and temperature (see **Figure 2.2**). In the humid tropics and subtropics, rainforest structure and diversity are closely related to soil factors, particularly nutrient availability (Webb 1969), but elsewhere climatic factors, notably seasonal drought or minimum temperatures (and frost) are more critical than soil parent material (Webb and Tracey 1981). Kahn and Lawrie (1987) reported that vine thickets on relatively nutrient-rich and nutrient-poor substrates in northern inland Queensland had similar species compositions.

The present study seeks to determine **whether there are definable patterns of species co-occurrence and co-abundance within the vine thickets of central and southern Queensland, whether these floristic assemblages correspond to the plant communities recognised within this region by Beadle (1981) and Nix (1977) and whether there are relationships between floristic patterns and diversity and environmental factors such as temperature, rainfall and soil parent material.**

3.1 Definition of study area

The geographical scope of this survey and subsequent floristic analyses is broadly defined by the Brigalow Belt Biogeographic Region which extends from Townsville to south of Gunnedah in northern New South Wales (Stanton and Morgan 1974, Thackway and Cresswell 1995). The northernmost section of the region has been recognised recently as a separate entity, the Northern Brigalow Belt (Thackway and Cresswell 1995) (see **Figure 3.1**).

This survey focuses on the central Brigalow Belt (equivalent to the Fitzroy River catchment) and adjacent areas in the Port Curtis and Burnett districts (part of the Southeast Queensland Biogeographic Region). Sub-units (provinces) have been delineated within these regions, largely on the basis of the major geologies and climates (e.g. Morgan 1988 unpublished) (see **Table 3.1**), and these are shown in **Figure 3.2**.

Table 3.1 Subunits (provinces) within the Brigalow Belt and Southeast Queensland Biogeographic Regions (see Figure 3.2)

Brigalow Belt Provinces	Map No.	Brigalow Belt Provinces	Map No.
BR 1. Anakie Inlier	**1**	BR 29. Moonie R. - Commoron Ck Floodout	**29**
BR 2. Southern Drummond Basin	**2**	BR 30. Mooonie - Barwon Interfluve	**30**
BR 4. Inglewood Sandstones	**4**	BR 31. Taroom Downs	**31**
BR 5. Eastern Darling Downs	**5**	BR 33. Banana - Auburn Ranges	**33**
BR 6. Dulacca Downs	**6**	BR 34. Boomer Range	**34**
BR 7. Carnarvon	**7**	BR 35. Marlborough Plains	**35**
BR 9. Macintyre - Weir Fan	**9**	BR 36. Mount Morgan Ranges	**36**
BR 10. Claude River Downs	**10**	BR 37. Southern Downs	**37**
BR 11. Upper Belyando Floodout	**11**	BR 38. Barakula	**38**
BR 12. Basalt Downs	**12**		
BR 13 Cape River Hills	**13**	**SEQ Provinces**	**Map No.**
BR 15. Beucazon Hills	**15**		
BR 16. Wyarra Hills	**16**	SE 1. Southern Coastal Lowlands	*
BR 17. Belyando Downs	**17**	SE 2. Southern Coastal Ranges	*
BR 18. Buckland Basalts	**18**	SE 3. Lamington - Springbrook	*
BR 19. Arcadia	**19**	SE 4. Western Scenic Rim	*
BR 20 Townsville Plains	**20**	SE 5. Southern Subcoastal Ranges	**C**
BR 21 Bogie River Hills	**21**	SE 6. Southern Subcoastal Lowlands	*
BR 22. Northern Bowen Basin	**22**	SE 7. South Burnett - Northeast Downs	**B**
BR 23. Isaac - Comet Downs	**23**	SE 8. Mary Valley	*
BR 24. Woorabinda	**24**	SE 9. Great Sandy	*
BR 25. Dawson River Downs	**25**	SE 10. Burnett - Curtis Coastal Lowlands	*
BR 26. Callide Creek Downs	**26**	SE 11. Burnett - Curtis Subcoastal Ranges	**A**
BR 27. Weribone High	**27**	SE 12. Burnett - Curtis Coastal Ranges	*
BR 28. Tara Downs	**28**	SE 13. Kroombit	*

* not mapped (see **Figure 3.2**).

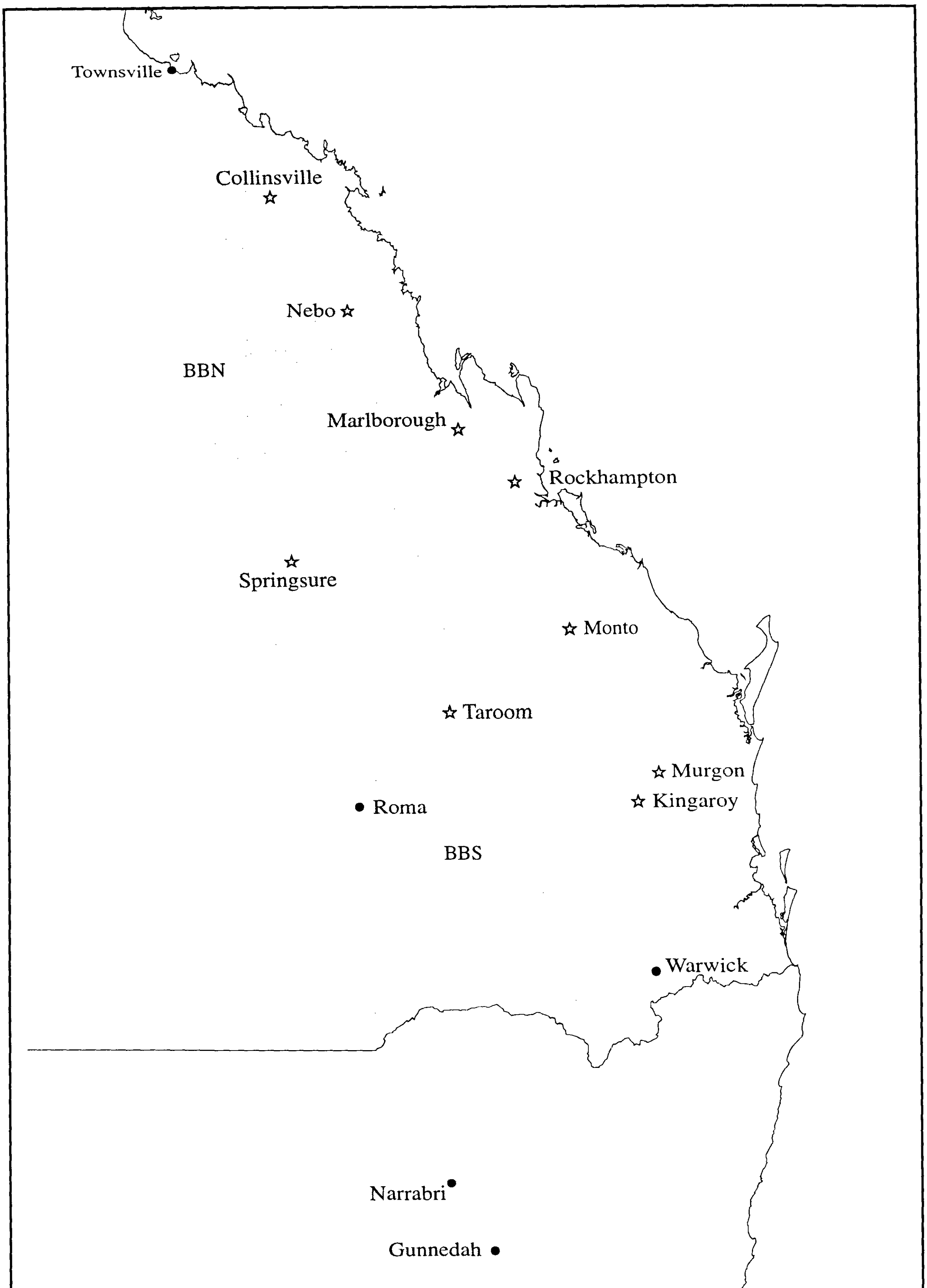


Figure 3.1 Map of Brigalow Belt Biogeographic Region, showing locations of major centres and climate stations (see **Table 3.2**).

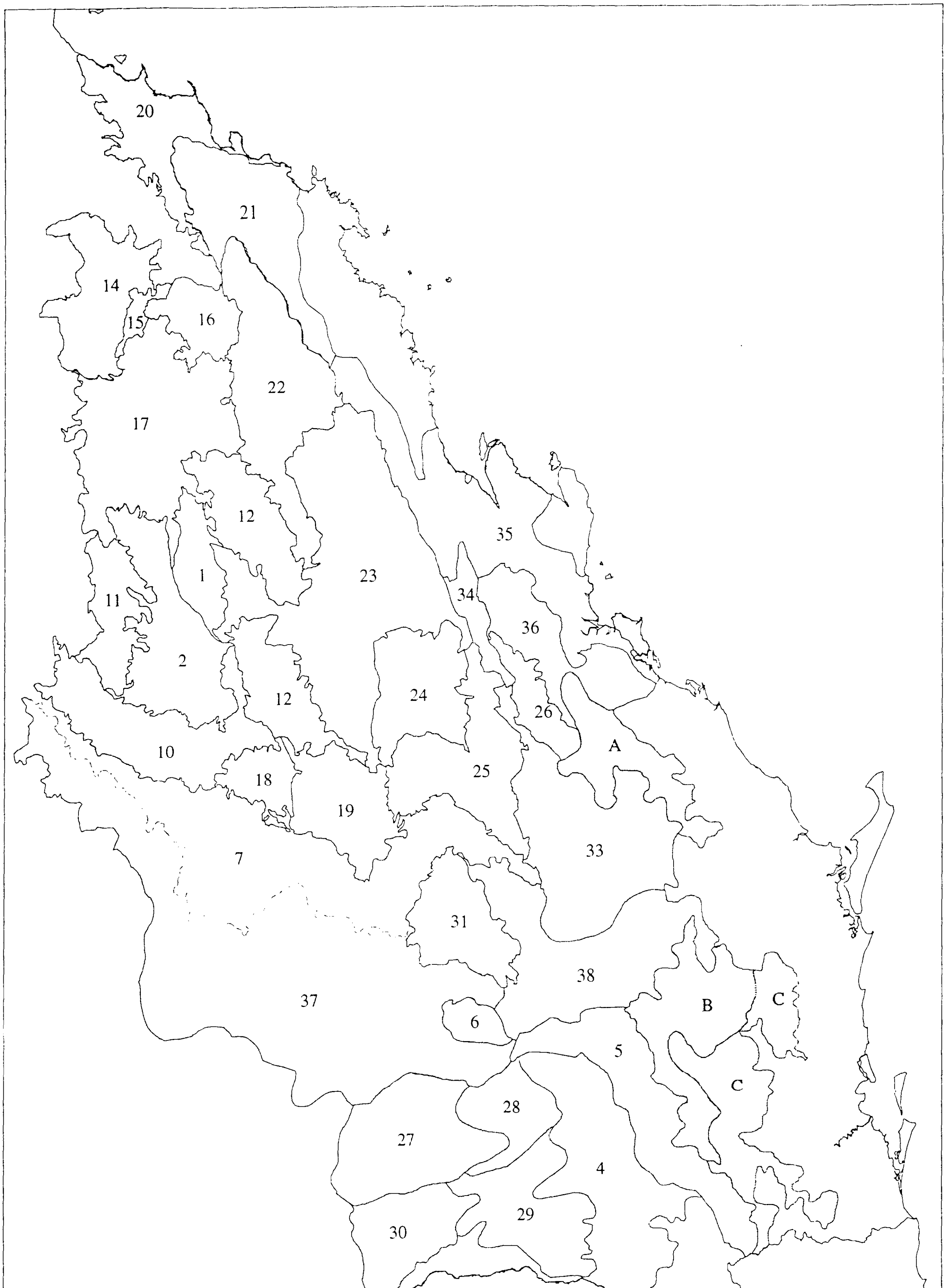


Figure 3.2 Subunits (provinces) of the Brigalow Belt Biogeographic Region and adjacent areas of Southeast Queensland (see **Table 3.1**).

Most of the 35 provinces within the Brigalow Belt Biogeographic Region carry little or no vine thicket vegetation. These communities are found mostly on the fine-textured Jurassic and Triassic sediments, the Tertiary basalts, acid and intermediate volcanics of Permian age and certain Quaternary and Tertiary sediments (Morgan 1988).

Brigalow Belt provinces with significant vine thicket occurrences include Claude River Downs (province BR10), Buckland Basalts (BR18), Arcadia (BR19), Isaac - Comet Downs (BR23), Taroom Downs (BR31), Dawson River Downs (BR25) and Boomer Range (BR34). SEQ provinces 7 (South Burnett - Northeast Downs) and 11 (Burnett - Curtis Subcoastal Ranges) are also significant. Brief descriptions of these provinces, based on Morgan (1988), follow:

<u>Province BR10</u>. **Claude River Downs**. An undulating to hilly province based on Triassic and Permian sediments in the southern part of the Galilee Basin. Predominantly undulating with brigalow and vine thicket (softwood) communities. Hillier areas carry *Eucalyptus* spp. (ironbark) and *Callitris* woodlands.

<u>Province BR18.</u> **Buckland Basalts**. A series of high dissected basalt tablelands with the underlying sediments, predominantly of Permian and Triassic age, exposed in the intervening valleys and gorges. Vegetation predominantly *Eucalyptus* grassy open woodland. In the north-west, slumped basalts and the underlying shale carry brigalow and vine thicket communities.

<u>Province BR19.</u> **Arcadia**. Formed primarily on Triassic sediments of the Bowen Basin with minor areas of Permian sediments in the east. Eastern, southern and western areas are predominantly rugged on coarse sandstone with *Eucalyptus* communities. The central and northern areas are more undulating and largely contained within a broad valley (the Arcadia Valley). Clay soils carry brigalow with areas of vine thicket, while the shallower texture-contrast soils have *Eucalyptus* (ironbark-poplar box) woodland.

<u>Province BR23.</u> **Isaac - Comet Downs**. This is a large, complex, undulating province dominated by Tertiary and other Cainozoic deposits. Tablelands and dissected remnants of the upper Tertiary surface are widespread, carrying *Eucalyptus* (ironbark) woodland on the earths of plateaus and *Acacia catenulata* and *A. shirleyi* communities on rocky hills and mesas.

The lower parts of the Tertiary surface are dominated by brigalow and *Eucalyptus cambageana* (Dawson gum) communities on undulating clay or texture-contrast soils, with some areas of vine thicket, e.g. Dipperu National Park.

Province BR31. **Taroom Downs**. An undulating province formed on the argillaceous sediments of the Injune Downs Group of the Great Artesian Basin. The vegetation is dominated by brigalow, with areas of vine thicket and blue-grass (*Dichanthium sericeum*) downs.

Province BR25. **Dawson River Downs**. An undulating province in which Bowen Basin sediments and Tertiary sediments outcrop in about equal proportions. The dominant Tertiary surfaces are of the lower catena. The Tertiary soils form undulating to flat plains dominated by brigalow and vine thicket communities. Exposed rocks of the underlying sedimentary basin form plains or hills with vine thickets. Province 26 (Callide Creek Downs) has close affinities with this province.

Province BR34. **Boomer Range**. A hilly to mountainous province formed on Permian volcanics and sediments, with areas of Devonian-Carboniferous sediments. The vegetation is dominated by *Eucalyptus crebra* and *Acacia rhodoxylon* communities. Areas of vine thicket occur on some hill slopes and ridge tops.

Province SE7. **South Burnett - Northeast Downs**. This province incorporates plateaus and hilly terrain associated with the Great Dividing Range and its spurs. Parent materials are predominantly basic volcanics, laterites and fine-grained sediments.

Province SE11. **Burnett - Curtis Subcoastal Ranges**. Parent materials in this province include metamorphics, acid and basic volcanics.

3.2 Climatic environment

The climate of the Fitzroy region was described in detail by the Department of National Development (1965) and for each of the three CSIRO study areas by Fitzpatrick (1967a, 1967b and 1968). These and other studies were reviewed by Lloyd (1984) in his account of the major climatic features of the Brigalow Belt.

The southern and eastern brigalow lands were classified by Dick (1975) (using Koeppen's classification) as Cfa climate (warm, moist with summer maximum) and northern areas and the Central Highlands were placed in a BSHw climate (hot, semi-arid with long winter dry season).

The climate of the Brigalow Belt Biogeographic Region is dominated by series of high pressure cells (anticyclones) moving across the Australian continent from west to east (Lloyd 1984). This high pressure band generally moves south in summer and northward in winter. These cells maintain mainly fine conditions over central and southern Queensland during winter, broken occasionally by frontal changes between successive high pressure systems. These changes bring cooler air, and sometimes rain, from the south-west. When the high pressure system moves south in summer, inland Queensland is dominated by a semi-permanent heat trough (Lloyd 1984). Moist, unstable air moving from the north-eastern tropics brings rain storms at this time.

The autumn and early spring are usually the driest periods in the brigalow region, but seasonal conditions may vary considerably due to changes in the paths of the anticyclones. A more northerly track in winter of high pressure systems allows rain-bearing fronts to move further north, while a more southerly track in summer allows moist equatorial air masses to penetrate further south than usual.

Major rainfall events are generally caused by either upper atmosphere low pressure systems (generally in summer) or deep surface depressions from decaying cyclones crossing the coast and moving inland in late summer. Both these influences may result in heavy flood rains, especially when they combine with the inland broad surface trough during the mid to late summer months.

Average annual rainfall totals range between 650 and 900 mm (see **Table 3.2**). More than half falls during summer (December-March) with up to 65% of the total annual rainfall for northern centres (e.g. Nebo, Marlborough) occurring during this period.

Apart from the seasonally dry period from late winter to early summer, extended dry periods are a normal feature of the Brigalow Belt Biogeographic Region. These droughts are frequently associated with El Nino-Southern Oscillation events (Partridge 1994). **Table 3.3** summarises the incidence of major (at least 12 months' duration) and extended (24 months and longer) droughts recorded for six centres in the brigalow region.

Table 3.2 Mean and median monthly rainfall (mm) for six centres in the Brigalow Belt Biogeographic Region of central and southern Queensland.
(Source: Clewett, Clarkson, Owens and Abrecht 1994).

Centre		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Nebo	mean	147	137	113	45	36	39	27	19	20	32	53	99	**769**
	median	114	106	88	27	22	29	14	9	8	18	43	91	**732**
Marlborough	mean	171	165	113	46	44	47	33	22	24	44	66	114	**890**
	median	118	126	81	30	30	28	15	12	16	32	52	98	**865**
Springsure	mean	106	113	70	40	36	37	31	24	29	44	63	91	**686**
	median	87	89	51	26	25	21	17	14	16	36	49	79	**644**
Taroom	mean	99	84	66	38	39	35	35	27	32	55	75	92	**679**
	median	92	61	52	25	25	27	24	20	22	46	61	80	**666**
Monto	mean	112	110	76	45	41	42	34	23	24	51	73	95	**728**
	median	104	85	56	35	27	31	22	17	16	42	61	84	**747**
Murgon	mean	116	104	79	50	42	44	41	28	36	69	80	113	**801**
	median	99	91	62	34	35	26	31	21	26	64	69	103	**782**

Table 3.3 Records of drought for six centres in the Brigalow Belt Biogeographic Region of central and southern Queensland.
(Source: Clewett *et al.* 1994)

Centre	No. of major droughts*	No. of extended droughts#	No. of years' records
Nebo	18	10	111
Marlborough	26	10	124
Springsure	23	10	118
Taroom	21	11	110
Monto	15	7	85
Murgon	16	10	85

* i.e. > 12 months duration

i.e > 24 months.duration.

Seasonal rainfall trends during the period of this survey (1987-1994) are shown in **Table 3.4** . In most centres, winter rainfall (Apr.- Sep.) was well above median values in 1988-90. Summer rainfall, on the other hand, was below the median for most years, especially in southern centres where only 1990/91 totals (for Murgon and Monto) exceeded the median summer value. Heavy summer rains associated with cyclonic activity were recorded for Nebo in 1987/88 and for both Nebo and Marlborough in 1990/91. In 1993 summer and winter rains were generally well below average for most centres, and this trend continued into 1994 and 1995.

Table 3.4 Trends in seasonal rainfall (mm) during 1987-1993 for six centres in the Brigalow Belt Biogeographic Region of central and southern Queensland.
(Source: Clewett *et al.* 1994)

Centre	Season	Median Rainfall (mm)	1987	1988	1989	1990	1991	1992	1993
Nebo	Oct. - Mar.	543	-137	+451	+25	+73	+907	-300	-271
	Apr. - Sep.	155	-25	+146	+409	+192	-103	-6	-84
Marlborough	Oct. - Mar.	594	-271	-204	-46	-85	+530	-218	-244
	Apr. - Sep.	191	-80	+234	+279	+56	-107	+20	-74
Springsure	Oct. - Mar.	462	+24	+22	+68	+109	-45	+101	-78
	Apr. - Sep.	178	+68	+22	+96	+140	-112	-20	-6
Taroom	Oct. - Mar.	455	-79	-24	-61	+1	-141	-58	-180
	Apr. - Sep.	193	-106	+33	+115	+78	-134	-17	-41
Monto	Oct. - Mar.	504	-7	-248	-2	-138	-163	+61	-245
	Apr. - Sep.	196	-3	+148	+199	+82	-101	+27	n.a.
Murgon	Oct. - Mar.	560	-93	-123	-84	-178	-107	+131	-182
	Apr. - Sep.	223	-50	+162	+210	+63	-155	+6	-70

Mean monthly temperatures are shown for six centres in **Table 3.5**. As noted by Lloyd (1984), winter temperatures (both maxima and minima) in northern areas of the brigalow region are significantly higher than in the south. Summer temperatures are generally similar throughout the region except in eastern (subcoastal) districts, where they are lower due to the influence of easterly air streams and associated cloud and rain. In number of days with heatwave conditions (temperatures greater than 35°C), Taroom (37 days) exceeds Springsure and even Collinsville (33 and 31 days respectively).

Frosts (temperatures <2.2°C) occur throughout the Brigalow Belt Biogeographic Region in winter although their severity depends on altitude and local topography, and they are relatively infrequent in northern areas (e.g. an average of 3 days/year at Collinsville). Taroom and Monto have similar incidences of frost (24 and 22 respectively), almost twice the number recorded at Springsure (14) and Brigalow Research Station (13), the latter centre only 100 km north of Taroom.

Table 3.5 Mean monthly temperatures (maxima and minima) for six centres in the Brigalow Belt Biogeographic Region.
(Source: Clewett *et al.* 1994)

Centre	Parameter	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Collinsville*	Max. temp.	33.1	32.7	31.7	30.2	27.3	25.0	24.8	26.9	29.5	32.0	33.5	33.7
	Days >35°C	7	5	1							2	7	9
	Min. temp.	21.5	21.5	19.8	16.6	13.4	9.9	8.6	10.3	13.2	16.9	19.9	20.9
	Days < 2.2°C						1	2					
Rockhampton*	Max. temp.	31.9	31.1	30.1	28.4	25.7	23.2	22.9	24.5	26.8	29.4	31.2	32.2
	Days >35°C	4	2	1							1	3	5
	Min. temp.	22.0	21.9	20.7	17.7	14.0	10.6	9.2	10.4	13.3	16.8	19.4	21.1
	Days < 2.2°C							1					
Springsure	Max. temp.	33.8	32.3	31.5	29.2	25.2	22.3	21.8	24.0	27.3	30.3	32.7	34.1
	Days >35°C	8	5	3							2	6	9
	Min. temp.	20.6	20.2	18.4	14.4	10.8	6.3	5.7	7.4	10.7	14.9	17.5	19.5
	Days < 2.2°C						4	6	3	1			
Taroom	Max. temp.	33.3	32.9	31.4	28.6	24.3	21.2	20.6	22.5	26.3	29.6	31.7	33.3
	Days >35°C	10	7	3							2	5	10
	Min. temp.	20.4	20.2	18.8	14.1	9.7	6.2	4.8	6.2	9.9	14.4	17.4	19.4
	Days < 2.2°C					1	5	11	6	1			
Monto	Max. temp.	31.9	31.2	29.9	27.6	24.1	21.0	20.6	22.6	26.0	28.9	30.8	32.0
	Days >35°C	6	3	1							1	3	6
	Min. temp.	19.1	18.8	17.2	13.6	10.2	6.6	5.1	6.5	9.4	13.2	16.0	18.1
	Days < 2.2°C					1	5	10	5	1			
Kingaroy*	Max. temp.	29.5	28.9	27.6	25.2	21.6	18.8	18.3	19.9	23.2	25.9	28.1	29.5
	Days >35°C	1	1									1	1
	Min. temp.	17.6	17.4	15.7	12.3	8.6	5.4	3.8	4.9	7.9	11.7	14.6	16.7
	Days < 2.2°C					2	7	13	10	3			

* No temperature data available for Nebo, Marlborough and Murgon.

3.3 Survey methodology

3.3.1 Selection of survey sites.

Within the Fitzroy Region, the survey was based on the mapped distribution of the major land systems in which vine thicket communities were known to occur, in particular Kareela/Bedourie/Womblebank and Racecourse/Eurombah land systems (Gunn *et al.* 1967, Speck *et al.* 1968 and Story *et al.* 1967). Areas with (possible) remnant vine thicket vegetation were indicated by Department of Primary Industries and Department of Environment field staff, as well as other experienced field workers, and their occurrences confirmed from aerial photography.

Other vine thicket remnants in south-eastern Queensland were located from remnant rainforest mapping by J.G. Tracey and J.P. Stanton (unpublished records of Queensland Department of Forestry, 1969-70).

Whilst the survey set out to sample each of the largest remnant areas of vine thicket, sites were also chosen to ensure adequate representation of the geographical ranges of the major land systems and/or geological formations which carry this community. Final choice of field sites was governed by accessibility using four-wheel drive vehicles.

The survey was carried out as a series of 1-2 week field trips between 1987 and 1994. Altogether 75 sites were examined during the study, and their distribution is illustrated in **Figure 3.3**. Their locations, abbreviated locality names and dates of survey are given in **Table 3.6**, together with the level of data collection. Detailed map references for each site, together with altitude and biogeographic province, are provided in **Appendix 3.**

3.3.2 Plot location and replication.

Within particular vine thicket patches, duplicate plots were established in areas of similar relief, generally within the same landscape sub-unit (landform element) (*sensu* McDonald, Isbell, Speight, Walker and Hopkins 1990). Plots were replicated in order to provide a means of testing the extent to which subsequent classificatory procedures could identify relationships between sites/patches rather than reflecting within-patch variation. This would then allow decisions on the appropriate level of the classificatory hierarchy for a regional vine thicket classification.

At sites 62 (Nantglyn), 64 (Reinkes Scrub) and 73 (Rookwood, now Goodedulla National Park), the positions of the subplots were deliberately varied so as to sample different slope positions and aspects.

At almost one-quarter of the sites (17), the limited time available meant that the replicate plots either had to be abandoned or restricted to nearest-neighbour (canopy) data only. These sites are indicated in **Table 3.6**.

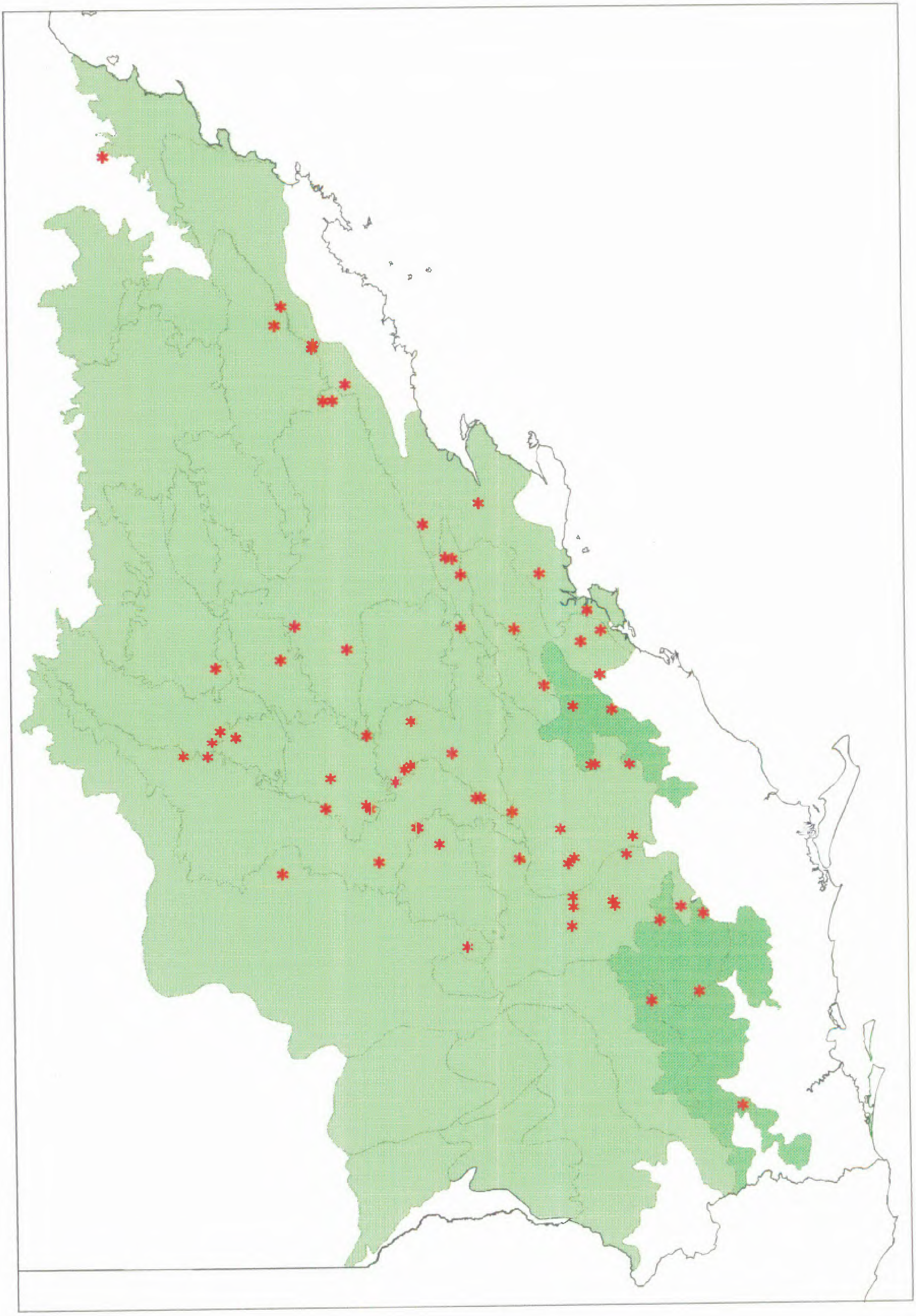


Figure 3.3 Survey of remnant vine thicket communities in central and southern Queensland - location of detailed sites and biogeographic provinces (see **Figure 3.2**).

Table 3.6 List of vine thicket sites, number of replicates and data collected from each subplot (see also Appendix 3).

SITE	LOCALITY	LOC. (ABBR.)	DATE	REP.#	BA	COV.	T/S	SPP	S/A
1	Portion 64 Woroon W of Windera	Windera	28/9/87*	3	A,B,C	A	A	A,B,C	A
2	Mt Narayen Narayen Research Station	Narayen A	29/09/87	2	A,B	A,B	A,B	A,B	
3	Dingo Trap Hill Narayen RS	Narayen B	29/09/87	2	A,B	A,B	A,B	A,B	
4	Koko Scrub State Forest 40	Koko	30/09/87	2	A,B	A,B	A,B	A,B	
5	Wonga Hills	Wonga Hills	30/09/87	1	A	A	A	A	
6	Cracow Mine	Cracow	1/10/87	2	A,B	A,B	A,B	A,B	
7	Brigalow Research Station	Brigalow RS	2/10/87	2	A,B	A,B	A,B	A,B	
8	Oombabeer Bauhinia Downs	Oombabeer	3/10/87	2	A,B	A,B	A,B	A,B	
9	W of Gogango Range Capricorn Highway	Gogango Ra.	3/10/87	1	A	A	A	A	
10	South Blackwater ooline site	S. Blackwater	4/10/87	2	A,B	A,B	A,B	A,B	
11	Wallalee Springsure	Wallalee	4/10/87	2	A,B	A,B	A,B	A,B	
12	Lake Nuga Nuga bonewood site	Nuga Nuga A	5/10/87	2	A,B	A,B	A,B	A,B	
13	Lake Nuga Nuga ooline site	Nuga Nuga B	5/10/87	2	A,B	A,B	A,B	A,B	
14	Dawson Highway Expedition Range	Expedition Ra.	6/10/87	2	A,B	A,B	A,B	A,B	
15	Cannondale Mt Expedition Range National Park	Amphitheatre A	7/10/87	2	A,B	A,B	A,B	A,B	
16	Transect Scrub Amphitheatre Expedition Range NP	Amphitheatre B	7/10/87	2	A,B	A,B	A,B	A,B	
17	Glenleigh E of Glenhaughton	Glenleigh	8/10/87	2	A,B	A,B	A,B	A,B	
18	Gerrards Scrub Glenhaughton Road	Gerrards Scrub	8/10/87	2	A,B	A	A	A,B	
19	South Mundubbera	S. Mundubbera	3/10/89	2	A,B	A	A	A	
20	Oakpark W of Eidsvold	Conclose	4/10/89	2	A,B	A,B	A	A,B	
21	Yarrol Scrub Monto	Yarrol Scrub	5/10/89	2	A,B	A,B		A,B	A
22	Koolkoorum Scrub Ubobo	Koolkoorum Scrub	7/10/89	2	A,B	A,B	A,B	A,B	A,B
23	Dan Dan Scrub (State Forest 53)	Dan Dan Scrub	8/10/89	2	A,B	A,B	A	A,B	A
24	Mount Larcom	Mount Larcom	9/10/89	2	A,B	A	A	A	A
25	Bracewell (Kearney's Scrub)	Bracewell	9/10/89	2	A,B	A	A	A	A
26	Rundle Range	Rundle Range	10/10/89	2	A,B	A,B	A,B	A,B	
27	Moores Creek Rockhampton	Moores Creek	11/10/89*	2	A,B	A,B	A	A,B	
28	Mount O'Connell Princhester	Mt O'Connell	12/10/89	2	A,B	A,B	A,B	A,B	A,B
29	Commanche Boomer Range	Commanche	13/10/89	2	A,B	A	A	A	
30	Mount Adder Road "Homevale"	Mt Adder Rd	15/10/89	2	A,B	A,B	A,B	A,B	A,B
31	Mt Hillalong Pipeline Road	Mt Hillalong	15/10/89	1	A	A	A	A	A
32	Bonewood Site Dipperu National Park	Dipperu A	16/10/89	1	A	A	A	A	A
33	Rockyvale Dululu	Dululu	17/10/89	2	A,B	A	A	A	A
34	Dry Creek Ka Ka Mundi (Carnarvon National Park)	Dry Creek	1/09/90	2	A,B	A,B	A,B	A,B	A,B
35	Bendee Site "Bonnie Doon" E of Gindie	Bonnie Doon A	6/9/90*	2	A,B	A,B	A	A,B	A
36	Oakwells W of Injune	Oakwells	30/04/92	2	A,B	A	A	A,B	A
37	Bullaroo Creek N of Injune (Carnarvon NP)	Bullaroo Creek	1/5/92*	2	A,B	A,B	A,B	A,B	A
38	Eastern Site Palmgrove National Park	Palmgrove A	2/05/92	2	A,B	A,B	A	A,B	A
39	Central Palmgrove	Palmgrove B	2/05/92	2	A,B	A,B	A	A,B	A
40	Palmgrove Creek	Palmgrove C	3/05/92	2	A,B	A,B	A	A,B	A
41	Welcome Section Carnarvon National Park	Welcome	6/05/92	2	A,B	A,B	A	A,B	A
42	Telemon Springsure	Telemon	6/05/92	1	A	A		A	
43	Bonewood Site "Bonnie Doon"	Bonnie Doon B	6/9/90*	2	A,B	A,B	A	A,B	A
44	Belah Site Dipperu National Park	Dipperu B	11/05/92	2	A,B	A,B	A	A,B	A
45	E of Denison Creek Nebo-Sarina Road	Denison Creek	12/05/92	2	A,B	A,B	A	A,B	A
46	Mount Britten "Homevale"	Mt Britten	13/05/92	2	A,B	A,B	A	A,B	A
47	Blenheim Creek	Blenheim Creek	14/05/92	2	A,B	A,B		A,B	
48	Mingela Bluff "Maidavale" E of Mingela	Mingela Bluff	15/05/92	2	A,B	A,B	A	A,B	A
49	Northern Scrub Isla Gorge National Park	Isla Gorge A	20/10/92	2	A,B	A,B	A	A,B	A,B
50	Ridge Site "Bimbadeen" Taroom	Bimbadeen A	27/10/92	2	A,B	A,B	A	A,B	A
51	Scrub Belt Site "Bimbadeen"	Bimbadeen B	27/10/92	2	A,B	A,B	A	A,B	A
52	Upper Zamia Creek Palmgrove National Park	Zamia Creek	29/10/92	2	A,B	A,B	A	A,B	A
53	Gurulmundi Ooline Reserve	Gurulmundi	30/10/92	1	A,B	A		A	A
54	Broad Gully Creek Scrub Ka Ka Mundi	Broad Gully Creek	6/05/93	1	A,B	A		A	
55	Bottletree Flat Ka Ka Mundi	Bottletree Flat	7/05/93	2	A,B	A,B	A	A,B	A,B
56	Upper Vandyke Creek "Kareela"	Vandyke Creek	9/05/93	1	A,B	A	A	A	A
57	Southern Expedition Range near "Yebna"	Yebna	12/05/93	2	A,B	A,B	A	A,B	A,B
58	Devils Nest Scrub Isla Gorge National Park	Isla Gorge B	13/05/93	1	A,B	A	A	A	
59	Nangur State Forest W of Goomeri	Nangur SF	6/7/93*	2	A,B	A,B	B	A,B	A
60	Northern Scrub Allies Creek	Allies Creek A	7/07/93	2	A,B	A,B	A,B	A,B	A,B

1. REP. = no. of replicates   3. COV. = cover class data   5. SPP. = all species (t/s/v)
2. BA = basal area data   4. T/S = counts of trees/shrubs   6. S/A = species/area data

* 1A (27/1/95), 27B (30/7/94), 35B (7/5/92), 37B (11/5/93), 43B (7/5/92), 59B (12/4/94).

Table 3.6 (cont.)

SITE	LOCALITY	LOC. (ABBR.)	DATE	REP.#	BA	COV.	T/S	SPP	S/A
61	Southern scrub remnant Allies Creek	Allies Creek B	7/07/93	1	A	A	A	A	A
62	State Forest 130 Mundowran N of Nantglyn	Nantglyn	8/07/93	3	A,B,C	A,B,C	A,B,C	A,B,C	A,B,C
63	Stuart Downs Wandoan	Stuart Downs	9/07/93	2	A,B	A,B	A	A,B	A,B
64	Reinkes Scrub Proston	Proston	######	2	A,B	A,B	A,B	A,B	
65	Peanga Logging Area Barakula State Forest	Peanga Scrub	######	2	A,B	A,B	A,B	A,B	
66	Walkers Creek Bunya Mountains National Park	Bunya Mts	######	2	A,B	A,B	A,B	A,B	
67	Cerberus Marlborough	Cerberus	######	2	A,B	A,B	A	A,B	A
68	Timber Reserve 140 Spier Callide Range	Callide Range	######	2	A,B	A,B	A	A,B	A
69	Terrace Site Coominglah State Forest	Hurdle Gully A	1/08/94	2	A,B	A,B		A,B	
70	Ridge Site Coominglah SF	Hurdle Gully B	1/08/94	2	A,B	A,B	A	A,B	
71	Dry Creek Kroombit Holding	Kroombit	2/08/94	2	A,B	A,B	A,B	A,B	
72	S of The Palms Goodedulla National Park	Rookwood A	3/08/94	2	A,B	A,B	A	A,B	
73	Crows Apple Scrub Goodedulla NP	Rookwood B	4/08/94	3	A,B,C	A,B,C	A	A,B,C	
74	Berlin Scrub Nature Refuge Mount Berryman	Mt Berryman	######	2	A,B	A,B	A	A,B	
75	Dean Logging Area Yarraman State Forest	Yarraman	######	1	A	A,B	A	A	A

1. REP. = no. of replicates   3. COV. = cover class data   5. SPP. = all species (t/s/v)
2. BA = basal area data   4. T/S = counts of trees/shrubs   6. S/A = species/area data

* 1A (27/1/95), 27B (30/7/94), 35B (7/5/92), 37B (11/5/93), 43B (7/5/92), 59B (12/4/94).

3.3.3 Plot enumeration and description.

3.3.3.1 Vegetation attributes

Sampling was based on a modification of the multiple nearest-neighbours ("point clump") approach recommended by Williams, Lance, Webb and Tracey (1973), who assessed a range of methodologies for the description and classification of moist rainforest communities. Each site was defined by the position of 32 trees about a central point. The minimum size of a tree was defined as 10 cm diameter-at-breast-height-over-bark (dbh) or, in the case of multiple-stemmed trees, having a collective basal area equivalent to that of a single 10 cm diameter stem. Williams *et al.* (1973) stipulated "canopy" trees, but an arbitrary minimum size was chosen for this study because of the difficulty of defining a dominant (canopy) layer in some of the more open stands, e.g. in bonewood (*Macropteranthes leichhardtii*) communities.

Many trees, particularly *Macropteranthes leichhardtii*, are multi-stemmed from the base. Two stems were taken as separate individuals if they were at least 10 cm apart at ground level.

Because of the difficulty of locating consecutive nearest neighbours as the plot radius increased, the plot was divided into 4 quarters, defined by compass bearings, i.e. 1 = NE (0-90°), 2 = SE (90-180°), 3 = SW (180-270°) and 4 = NW (270-360°) (see **Figure 3.4**). The area of each subplot was calculated from the distance of tree 8 from the plot centre (r), and summed to give the plot area; i.e.

$$A = \frac{\pi \ (r_1^2 + r_2^2 + r_3^2 + r_4^2)}{4}$$

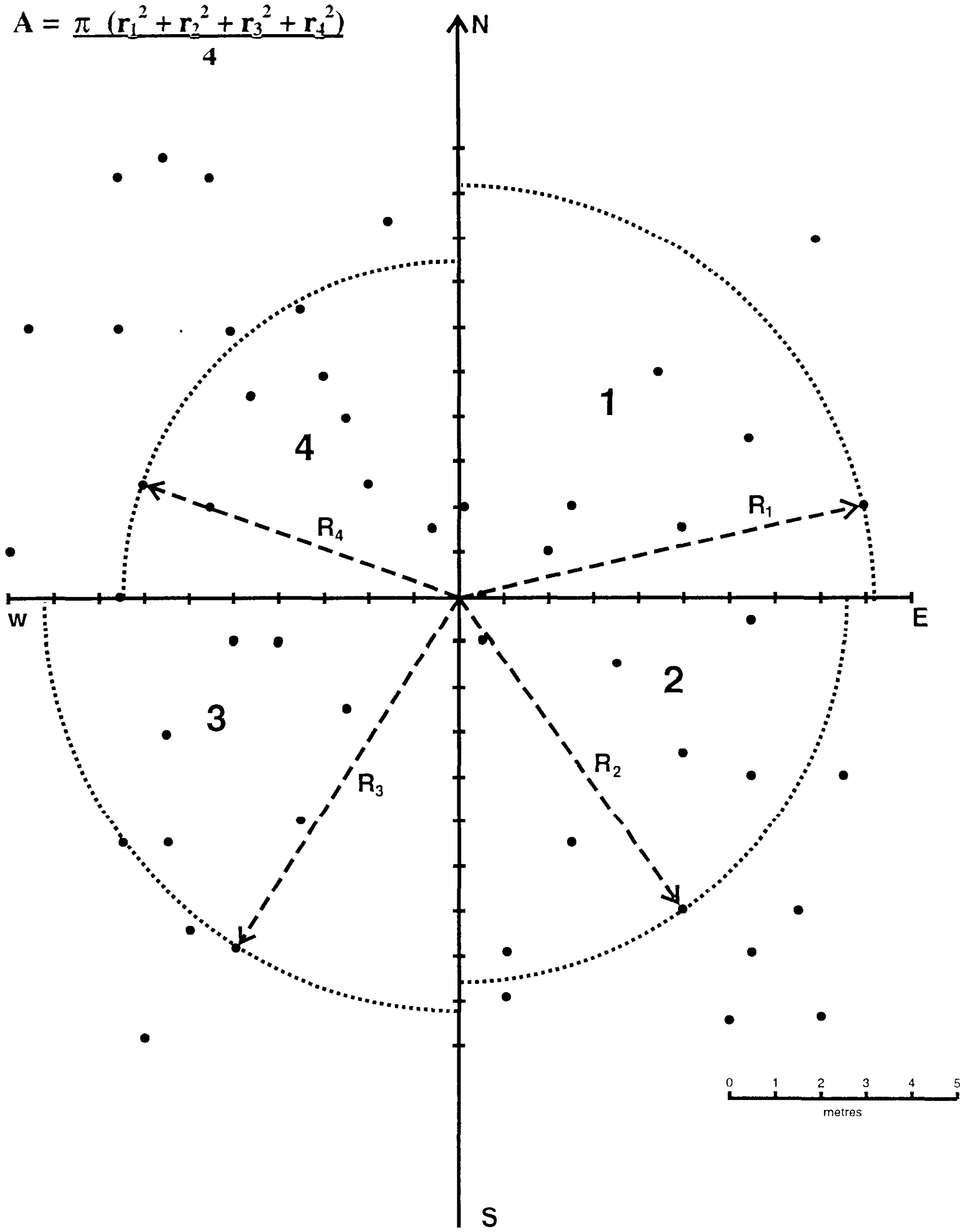


Figure 3.4 Design of plotless sample (32 nearest neighbours) - remnant vine thicket survey.

Use of this formula produces an underestimate of the area occupied by the tree sample and hence an overestimate of tree basal area. Although this sampling procedure is similar in some respects to the point-centred quarter method of Cottam and Curtis (1956), their calculation of mean area, based on the square of the mean distance of the nearest tree in each quarter, cannot be applied to a multiple nearest-neighbours sample.

In the absence of a suitable data set from vine thicket vegetation, data from a series of 20 m X 20 m plots in araucarian vine forest in the upper Mary River Valley (McDonald, Young & Ryan, unpublished) were used to develop a correction factor. This is based on half the incremental increase in plot area (as calculated above) between two consecutive trees in each quarter, i.e.

$$\textbf{Corrected Area (CA)}_n = A_n + \frac{(A_{n+1} - A_n)}{2}$$

where n = the nth neighbour in each quarter

The following regression relationship was established (see **Figure 3.5**);

$$\mathbf{CA = 1.089A\ (r^2 = 0.9825)}$$

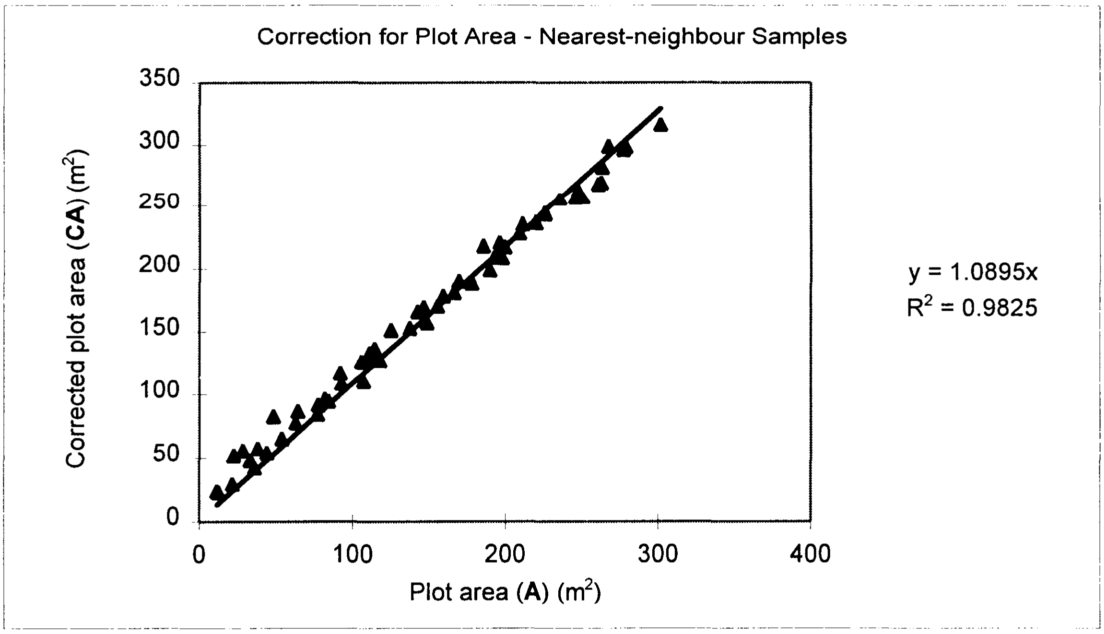


Figure 3.5 Regression relationship for adjustment of areas of plotless samples, based on data from araucarian vine forest sites in the Mary River Valley.

Using corrected areas derived by the Cottam and Curtis formula

(i.e. Mean Area = $\left(\frac{r_1 + r_2 + r_3 + r_4}{4}\right)^2$) produces the following relationship;

$$\mathbf{CA = 1.254A\ (r^2 = 0.996).}$$

Thus applying the Cottam and Curtis formula would result in plot areas being overestimated by approximately 15%.

Stem diameter was recorded (as diameter-at-breast-height-over-bark (dbh) (i.e. at 1.3 m)) for each of the 32 "canopy" trees. In multi-stemmed trees, the diameters of all stems exceeding 3 m in height were recorded. The height of each tree (in metres) was estimated against a 3 m fibreglass measuring pole (sites 27-74). Other features noted were condition of tree (e.g. presence of mistletoes, crown death and insect defoliation), presence of charcoal/fire scars on the trunk and phenology (whether flowering or fruiting, deciduous, etc.).

For at least one plot at each site (if time permitted) low trees and tall shrubs (≥3 m high, ≤10 cm dbh) were counted and their heights also estimated. Low shrubs (<3 m) were recorded only in terms of presence/absence data, except during early field trips (sites 2-24), when all shrubs were counted. Ground species (subshrubs, graminoids, ferns, etc.) were listed or collected for subsequent identification. Vine/liana species were also recorded, together with the stratum in which they predominantly occurred (i.e. canopy, mid-strata and ground layer). Vascular epiphytes were also noted, together with their host tree/shrub.

For each tree, shrub and ground cover species, its total projective canopy cover was visually estimated in one of 7 classes, viz.

1	<1%
2	1-4.9%
3	5.0-9.9%
4	10.0-24.9%
5	25.0-49.9%
6	50.0-74.9%
7	75.0-100%.

Crown cover was chosen (rather than foliage cover) because of the large numbers of deciduous and seasonally leafless or near-leafless tree species in these communities. During the latter half of the project (sites 37-74), cover was estimated in 5% intervals (e.g. 10.0-14.9, 15.0-19.9, etc.). These values were later converted to the broader classes above.

Summary data were also collected for each plot, comprising height range and projective canopy cover of each stratum. Large individuals of emergent tree species (e.g. *Brachychiton* spp., *Flindersia australis*) growing near, but not sampled by the plots, were also recorded.

3.3.3.2 Site attributes

Aspect, slope angle and position in landscape were recorded for each plot. Aspect was later coded to reflect increasing exposure, as carried out by Keith (1994); i.e. 1 = 120-210°, 2 = 30-120° and 210-300° and 3 = 0-30° and 300-360°.

Landform attributes were simplified from the categories defined by Speight ((1990). Four classes of terrain (landform pattern) were recognised; undulating (U), low-hilly (LH), hilly (H) and steep-hilly (SH). Landform elements were grouped into 5 categories; crests (C), upper slopes (U), mid-slopes (M), lower slopes (L) and foot-slopes (F).

Plot locations were initially marked on aerial photographs and later transferred to topographic maps to determine grid references and altitude. As the survey progressed, the availability of satellite-based global positioning systems allowed precise readings of latitude and longitude to be made in the field.

The geological formations represented at each site were determined from 1:250 000 geological maps (Queensland Department of Minerals and Energy) and the CSIRO land system maps and reports. If there was doubt concerning the mapped unit, specimens of parent material were collected for determination. Geological substrates were grouped into 5 broad categories, i.e. (A) acid volcanics (e.g. granite/granodiorite), (I) mixed/intermediate volcanics (e.g. andesite) (formations with interbedded sediments, metamorphics and volcanics are included here), (B) basic volcanics (i.e. basalt), (S) sediments (mudstones, claystones, shale, etc.) and (C) Cainozoic deposits (colluvia, etc.) overlying other material. These data are presented in **Appendix 4.**

Apart from features such as fire scars (see above), note was taken of dead and dying trees (both standing and fallen). The presence of introduced and native grazing animals (cattle/horses and macropods) was recorded from tracks (pads), camps and droppings, and their impact noted, e.g. heavy browsing of shrubs. The presence of brush turkey mounds and their status, i.e. whether active or abandoned, were also noted.

3.3.3.3 Climatic attributes

Because of the large number and geographical spread of the survey sites, no attempt was made to collate climatic data from Bureau of Meteorology records. Instead, a climatic profile consisting of 16 attributes (mainly temperature and rainfall - see **Table 3.7**) was generated for each site using the bioclimatic analysis and prediction system BIOCLIM (Version 2.0) (Busby 1991) by the Environmental Resources Information Network (ERIN) unit, Department of Environment, Sport and Territories. An expanded data set comprising 35 parameters, including radiation and moisture indices, was generated by the ANU Centre for Resource and Environmental Studies in June 1995 using BIOCLIM Version 3.6 (McMahon, Hutchinson, Nix and Ord 1995) (see **Table 3.7**).

Table 3.7 List of climatic attributes generated by BIOCLIM Versions 2.0 (i) and 3.6 (ii).
(see **Appendix 5** for complete data sets)

No. (i)	No. (ii)	Parameter	No. (i)	No. (ii)	Parameter
1	1	Annual Mean Temperature	16	19	Precipitation of Coldest Quarter
	2	Mean Diurnal Range(Mean(period max-min))		20	Annual Mean Radiation
	3	Isothermality (2/7)		21	Highest Period Radiation
	4	Temperature Seasonality (C of V)		22	Lowest Period Radiation
2	5	Max Temperature of Warmest Period		23	Radiation Seasonality (Cof V)
3	6	Min Temperature of Coldest Period		24	Radiation of Wettest Quarter
4	7	Temperature Annual Range (5-6)		25	Radiation of Driest Quarter
7	8	Mean Temperature of Wettest Quarter		26	Radiation of Warmest Quarter
8	9	Mean Temperature of Driest Quarter		27	Radiation of Coldest Quarter
6	10	Mean Temperature of Warmest Quarter		28	Annual Mean Moisture Index
5	11	Mean Temperature of Coldest Quarter		29	Highest Period Moisture Index
9	12	Annual Precipitation		30	Lowest Period Moisture Index
10	13	Precipitation of Wettest Period		31	Moisture Index Seasonality (C of V)
11	14	Precipitation of Driest Period		32	Mean Moisture Index of High Qtr. MI
12	15	Precipitation Seasonality(C of V)		33	Mean Moisture Index of Low Qtr. MI
13	16	Precipitation of Wettest Quarter		34	Mean Moisture Index of Warm Qtr. MI
14	17	Precipitation of Driest Quarter		35	Mean Moisture Index of Cold Qtr. MI
15	18	Precipitation of Warmest Quarter			

3.4 Data processing and analysis

Data were transferred from the field sheets to the CORVEG database (a FOXPRO application) developed for vegetation data collected by Queensland Herbarium staff. Files were downloaded to Microsoft Excel for sorting and other manipulation, and also prepared for numerical analysis using the PATN package (Belbin 1992). Analyses of variance and other statistical procedures were carried out using the Statistica for Windows package (Statistica 1994).

3.4.1 Description of data sets

Three groups of data were analysed:

(i) tree dbh/basal area data (142 plots)

For each species a **relative importance** value was calculated, which has two components, **relative dominance** and **relative density**.

$$\text{Relative dominance} = \frac{\text{Dominance of species X 100}}{\text{Dominance of all species}}$$

$$\text{i.e.} = \frac{\text{Basal area of species X 100}}{\text{Total basal area of plot}}$$

$$\text{and relative density} = \frac{\text{Number of individual of species X 100}}{\text{Total number of individuals}}$$

Relative importance is calculated as the mean of relative dominance and relative density. It is not to be confused with the importance value of Curtis and McIntosh (1950), which has a third component, **relative frequency** (Mueller-Dombois and Ellenberg 1974).

$$\text{Relative frequency} = \frac{\text{Frequency of species X 100}}{\text{Sum frequency of all species}}$$

and importance value (I.V.) = Relative dominance + relative density + relative frequency.

Because of the overall small numbers of replicates, relative frequency (per site) would have been of little value in the calculation of importance.

(ii) cover class values (trees, shrubs and subshrubs) (133 plots)

Although estimates of cover % were made for the ground cover species, it was decided not to use these data in classifications, because of the difficulties in reliably identifying species of graminoid plants in the absence of inflorescences, and because of the varying seasonal conditions when the data were collected and the different intensities of grazing by macropods.

Grazing/browsing was most pronounced in the smaller, more isolated remnants, particularly those with improved pasture or cropping adjacent.

(iii) presence/absence data (trees, shrubs, subshrubs and vines) (136 plots)

In these analyses the ground stratum species were again excluded because of the difficulties of species determinations for the graminoid plants and other reasons outlined above.

3.4.2 Numerical analyses

Analyses were carried out on a personal computer using various modules within the PATN package (Belbin 1991, 1992). Each procedure in PATN is menu-driven, offering a number of options, with the recommended (default) option generally being justified in the technical manual (Belbin 1992). The DECODA package (Minchin 1990) was used for the larger TWINSPAN analyses (see below).

Dissimilarity matrices were calculated for relative importance, cover class and presence/absence data using the Bray-Curtis coefficient (Bray and Curtis 1957) (when used with presence/absence data, it is generally known as the Czekanowski coefficient).

$$\text{Dissimilarity} = \frac{1 - (2 \times \text{sum of lesser scores of species common to two quadrats})}{\text{Sum of total species scores for both quadrats}}$$

The Bray-Curtis coefficient is recommended (Belbin 1992) because it is an "asymmetric" measure (i.e. 0 - 0 matches are not taken into account) and it is considered robust to variations in the response curves of species to environmental gradients (Faith, Minchin and Belbin 1987, Keith 1994). In a range of tests with simulated ecological data, Faith *et al.* (1987) found three measures, the Bray-Curtis, quantitative symmetric (Kulczynski) and relativized Manhattan measures, to have both a strong monotonic (rank order) relationship with ecological distance and a robust linear relationship until ecological distances became large.

Prior to calculating dissimilarity values, cover class data were standardised by adjusting species values to a scale of 0 to 1, using the formula

$$\text{Cover (stand.)} = \frac{\text{Cover value - minimum value for species}}{\text{Range (maximum-minimum values) for species}}.$$

For this data set, this standardisation was equivalent to dividing by the maximum value recorded for each species (another PATN option), since no species occurred in all plots, i.e. all species had a minimum value of 0.

Analyses based on presence/absence data were also carried out on part data sets, e.g. tree/shrub species versus trees/shrubs/vines and data sets with "singleton" species (i.e. those recorded once only) removed.

Classification was carried out on all data sets using **agglomerative hierarchical fusion** - the FUSE module (within PATN) which is a group of polythetic agglomerative procedures based on many of the SAHN strategies (Sequential-Agglomerative-Hierarchical-Combinatorial) of Sneath and Sokal (1973). The default option was chosen, **flexible unweighted pair-group mean averaging** (UPGMA), with a β parameter value of -0.1. Use of a zero or negative β value prevents space contraction between the groups (and hence a tendency for chaining behaviour) as clustering proceeds (Williams, Clifford and Lance 1971, Belbin 1992). Belbin, Faith and Milligan (1992) reported that a slightly negative β appeared to be more successful in recovering known groups than other strategies.

In addition to the site classifications, hierarchical classifications of species were carried out to provide ordering for two-way (site x species) tables. Data matrices were transposed and the Two-Step association measure (Austin and Belbin 1982) applied, followed by flexible UPGMA clustering.

A classificatory analysis using the polythetic divisive procedure, two-way indicator species analysis (TWINSPAN) (Hill 1979a), was also carried out on the presence/absence data. Divisive procedures have a theoretical advantage over the agglomerative methods in that they reach a practical group level in relatively few iterations (and are most accurate at this level), whereas the latter methods have to carry out many more iterations (with more opportunity for error) until a comparable group level is reached (Belbin 1992). On the other hand, errors early in the divisive process have major implications for the rest of the procedure.

TWINSPAN divides sites on the basis of the first axis of a reciprocal-averaging ordination. It has been used to classify large data sets from vine thicket communities in the Northern Territory (Russell-Smith 1991) and inland northern Queensland (Fensham 1995). Belbin and McDonald (1993), however, reported that TWINSPAN was less successful in retrieving natural clusters in a simulated ecological data set than the agglomerative procedures flexible-UPGMA and ALOC (a non-hierarchical procedure) (Belbin 1987).

Two ordination procedures within PATN, detrended correspondence analysis (DCA) and semi-strong-hybrid multidimensional scaling (SSH), were used to examine relationships among plots and identify possible environmental gradients.

Minchin (1987) compared five ordination techniques, principal components analysis (PCA) , principal co-ordinate analysis (PCoA), DCA (DECORANA), Gaussian ordination (GO) and local non-metric multidimensional scaling (LNMDS). They were tested against a series of artificial data sets simulating community variation along environmental gradients. PCA and PCoA were shown to be ineffective because of curvilinear distortion - PCoA gave comparable results to LNMDS only for models with very short gradients.

DCA performed poorly with the more complex species response models and non-regular sampling patterns. Minchin also commented that much of the considerable distortion in DCA ordinations could be artificial, arising from the use of Chi-squared distance as the dissimilarity measure and/or the effects of detrending or rescaling. LNMDS was recommended as the most appropriate technique for indirect gradient analysis.

SSH is recommended by Belbin (1992) as an improved version of hybrid multidimensional scaling (as proposed by Faith *et al.* 1987), which combines metric and non-metric analyses, i.e. using linear and monotonic (rank order) relationships with two copies of the association matrix. The linear regression is applied to a dissimilarity matrix in which values above a prescribed threshold are treated as missing. In SSH a single association matrix is analysed, with interval or ratio regression used on the values below the threshold (or cut) and ordinal regression on those above (Belbin 1992).

In the present study an initial series of SSH ordinations was carried out on relative importance and cover class data using 10 random starting configurations in each of 1 to 8 dimensions to determine the solution with the lowest stress (i.e. the best rank-order agreement with the association matrix). The stress values (see **Table 3.8**) are graphed against number of dimensions in **Figure 3.6,** which suggests that at least 5 dimensions are required to reach the recommended stress level, i.e. < 0.15.

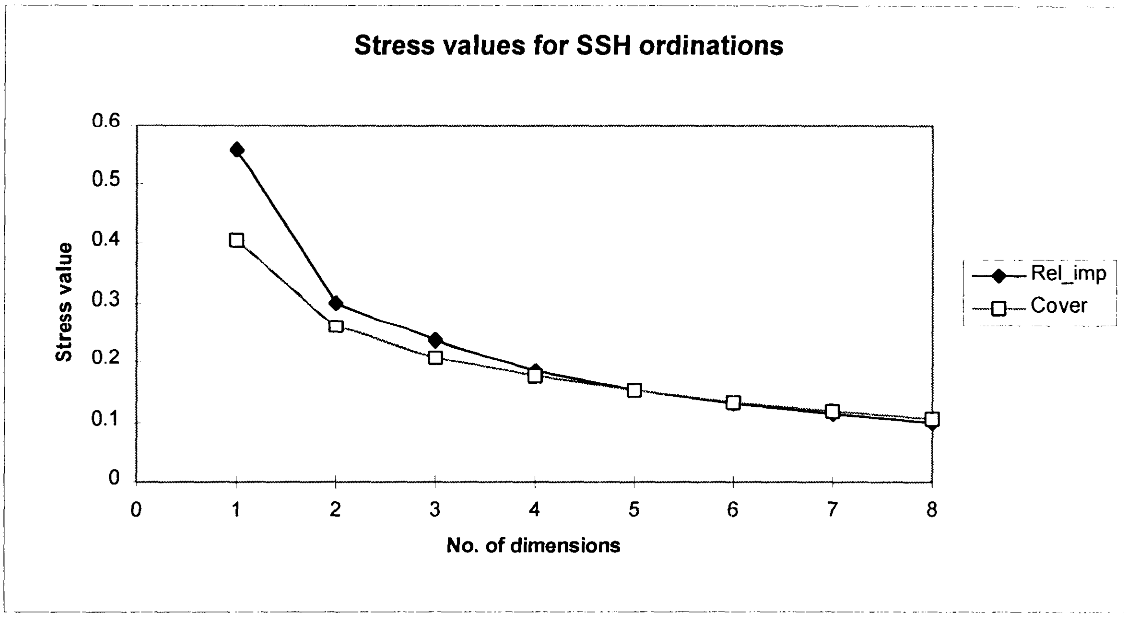


Figure 3.6 SSH ordinations (semi-strong-hybrid multidimensional scaling) - stress values and numbers of dimensions (see also Table 3.8)

The SSH axes were rotated to simple structure (Belbin 1992) using the principal axis rotation (PCR) option, prior to producing scatter plots of the ordinations. These results are referred to as SSR.

Table 3.8 Semi-strong hybrid multidimensional scaling (SSH) - dimensions and corresponding stress values for ordinations with relative importance and cover data (see also Figure 3.6).

No. of dimensions	Stress values: Rel. importance data	Stress values: Cover class data*
1	0.55675	0.40493
2	0.29959	0.25951
3	0.23476	0.20745
4	0.18539	0.17650
5	0.15348	0.15255
6	0.13054	0.13336
7	0.11398	0.11788
8	0.10017	0.10556

* (standardised)

3.4.3 Other statistical analyses

Spearman rank order correlation coefficients were calculated between biomass and diversity measures for the vine thicket plots and 16 climatic parameters (BIOCLIM 2.0 - see **Table 3.7**). Relationships between classificatory groups and climatic parameters were explored using the group statistics (GSTA) programs within PATN.

The Kolmogorov-Smirnov test for normality showed most of the climatic (BIOCLIM) data to be non-normal (and generally skewed) in its distribution. The recommended (logarithmic) transformations were unsuccessful in normalising these data. Analyses of variance were therefore carried out using the Kruskal-Wallis ANOVA by Ranks test, a non-parametric procedure within the Statistica package (Statistica 1994).

No non-parametric procedure was available for the determination of level of significance of differences between group means, so the Tukey honest significant difference (HSD) test for unequal numbers (Spjotvoll and Stoline 1975) was used. This was considered to be a valid test because analysis of variance had shown all group effects to be highly significant (see **Table 3.27**).

3.5 Results of survey

3.5.1 Vine thicket plant taxa

More than 375 vascular plant taxa were recorded from the 75 sites (142 plots) in this study (see **Appendix 2)**. Numbers of species in the data sets included 131 species in the canopy tree (>10 cm dbh) data (31 recorded once only), 221 species (trees/shrubs) in the cover class data (34 once only) and 255 species (trees/shrubs/vines) in the presence/absence data set (44 species once only).

Difficulties were experienced in the identification of several taxa in the field. *Austromyrtus bidwillii* probably comprises two taxa, var. *bidwillii* which has pinkish bark and is found in the moister sites and var. *racemulosa*, found in central Queensland, which has bluish bark (G.P. Guymer pers. comm.). These two taxa cannot be consistently distinguished in the absence of flowering/fruiting material and were recorded as a single taxon in the present study.

There is also some taxonomic confusion in the genus *Canthium*. Five taxa were recognised; *Canthium odoratum, C. buxifolium*, an undescribed species known as *C.* sp. "brigalow", *C. coprosmoides* and *C. vacciniifolium*. Two forms were apparent in *Canthium odoratum*, a smaller, dark, glossy-leaved form and a form with large, dull, relatively yellowish foliage. *C. buxifolium* has small rounded glossy leaves and is common in the Burnett district. *C.* sp. "brigalow" also has small leaves, drawn out at the base, and is widespread through the brigalow region. In the Mundubbera district, there were populations intermediate in form between *C. buxifolium* and *C.* sp. "brigalow".

Canthium coprosmoides comprises several taxa, with at least two occurring in the study area (S. Reynolds pers. comm.). *Canthium vacciniifolium* is a common understorey shrub in many vine thicket stands. In the moister communities, e.g. Coominglah, Nantglyn, Mt Berryman, a closely related species *C. microphyllum* was recorded. The two species tend to intergrade and Reynolds (pers. comm.) regards them as distinct varieties only (of *C. vacciniifolium*). They have been combined in the present study.

Two varieties are recognised within the tree species *Euroschinus falcata*: var. *falcata* and var. *angustifolia*. The former variety occurs throughout coastal Queensland, whereas var. *angustifolia* is known from northern and central Queensland (Henderson 1994), generally in drier situations than var. *falcata*. The Callide Range (site 68) specimens appeared intermediate in leaflet dimensions, and a decision was made to combine data for the two taxa.

Planchonella cotinifolia has two varieties, *cotinifolia* and *pubescens*, the latter being by far the most widespread and common in the brigalow region. Var. *cotinifolia* was recognised as occurring only in the most easterly, moist sites, e.g. Yarraman, Nantglyn and Yarrol. Populations at Windera and Allies Creek were also placed (with some reservations) in this taxon. Forster, Bostock, Bird and Bean (1991) did not distinguish between these taxa.

Forster *et al.* also combined records for *Geijera salicifolia* var. *salicifolia* and *G. salicifolia* var. *latifolia* and for *Cassine australis* var. *australis* and *C. australis* var. *angustifolia*. Difficulties in determining relatively broad-leaved taxa of *Geijera* were experienced in the Burnett district (*G. salicifolia* is also believed to hybridise with *G. parviflora*). *Cassine australis* var. *angustifolia* is the more widespread taxon within the study area, but broad-leaved populations in the Nebo district have been identified as disjunct occurrences of *C. australis* var. *australis*.

During the course of this study, it became apparent that southern populations of what was then known as *Macropteranthes fitzalanii* in fact represented a distinct species, since described by Forster (1994) as *M. leiocaulis*. The bonewood population at Dipperu National Park, initially identified as *M. leichhardtii*, has now been determined from flowering and fruiting specimens to be *M. leiocaulis*.

Natural hybrids are relatively rare in rainforest communities, but apparent hybrids between *Ehretia membranifolia* and *E. grahamii* (Forster 1995) were recorded in vine thickets in the Nebo district and a hybrid between *Brachychiton rupestris* and *B. populneus* subsp. *trilobus* (*B. X turgidulus*) (Guymer 1988) was recorded west of Injune.

Reference has already been made to the difficulties of distinguishing between species of graminoids. This was a particular concern in *Cyperus* spp., with a dwarf sedge recorded (as *C. gracilis*) from most sites in this study. It appears now that many of these records represent the species *C. curvistylis*.

3.5.2 Structure and life forms

Most of the stands surveyed fit the category of semi-evergreen vine thicket as defined by Webb (1968, 1978a), with some examples of (arguably) deciduous vine thicket in northern sites (e.g. Mt Hillalong (site 31) and Mingela Bluff (site 48)) and araucarian vine forest/thicket in the moister south-eastern sites (e.g. Yarraman (site 75)). There was however considerable variation in height and density of the canopy, the number of subordinate strata and the types of emergents. The most consistent features structurally were the large emergent bottle trees (*Brachychiton rupestris* and *B. australis*) which occurred throughout most of the study area and the sparseness or even complete lack of a herbaceous ground stratum in all but the most open, transitional stands (e.g. *Acacia harpophylla*/vine thicket communities (see below)).

Apart from the *Brachychiton* spp., emergent species included the leguminous trees *Archidendropsis thozetiana, Lysiphyllum hookeri* and *L. carronii* (the latter in transitional areas to open communities, e.g. patchy plains), *Sterculia quadrifida, Gyrocarpus americanus, Euroschinus falcata, Flindersia australis*, *Terminalia oblongata* and *T. porphyrocarpa*. All are deciduous for at least a short period in the dry late winter-spring season. Another emergent in some stands, ooline (*Cadellia pentastylis*) frequently dominated the communities in which it occurred.

Many stands had scattered emergent *Acacia harpophylla* and/or *Casuarina cristata* and intergraded with communities dominated by these species, generally downslope and/or on heavier soils (e.g. see **Chapter 5**).

The canopy layer in vine thickets is often quite uneven in height and density, with a trend towards lower, more open stands in rocky situations (e.g. scree slopes) and/or with decreasing rainfall inland. Individual trees ranged in habit from single-stemmed with narrow (e.g. *Flindersia collina*) or spreading crowns (e.g. *Owenia venosa*) to multiple-stemmed from near the base or below ground level, as in *Macropteranthes leichhardtii* or *Backhousia angustifolia*. The two varieties of *Planchonella cotinifolia* showed contrasting habits, var. *cotinifolia* tending to be erect and more or less single-stemmed, while var. *pubescens* was a very low, spreading tree which generally branched below breast height.

Canopy leaves were predominantly microphyll in size and many species may shed most of their leaves in drought periods, e.g. *Macropteranthes* spp., *Strychnos axillaris* and *Excoecaria dallachyana*.

Most vine thickets had a subordinate layer of low trees and/or tall shrubs, which included characteristic species such as *Ehretia membranifolia, Croton insularis*, *Canthium* spp., *Austromyrtus bidwillii* and *Planchonella cotinifolia* var. *pubescens*. These species, while not typically part of the canopy, consistently had trunk diameters of 10 cm or greater. *Canthium vacciniifolium, Croton phebalioides* and *Turraea pubescens*, however, rarely reached this size.

Acalypha eremorum often formed a dense, spinescent shrub layer 2-4 m high and was also a feature of transitional communities. In relatively moister areas of south-eastern Queensland, it grows with or may be replaced by *A. capillipes*. Another characteristic shrub species in many vine thickets is *Carissa ovata*, which often has an ascendant habit and is armed with paired axillary spines.

Subshrubs (soft-woody species) included *Spartothamnella juncea*, *Solanum* spp., *Olearia canescens* and *Abutilon oxycarpum* f. *acutatum*. The latter was particularly common in more open thickets but others, e.g. *Solanum corifolium*, appeared to prefer more shaded, moister situations. In eastern central and southern Queensland, the alien subshrub *Rivina humilis* was locally prominent.

While lianas are a characteristic feature of vine thicket communities, those in the drier inland communities tended to be relatively slender and for the most part not conspicuous in the canopies. They included ephemeral species such as *Passiflora aurantia* and *Diplocyclos palmatus*, while *Cissus opaca* dies back seasonally to a tuber. In the moister eastern thickets and/or in locally favourable situations such as watercourses, more robust lianas such as *Austrosteenisia blackii, Cissus oblonga* and *Glossocarya hemiderma* were frequent.

Although, as noted above, most vine thickets except the more transitional and/or disturbed stands lacked a well-defined ground stratum, there was a considerable variety of herbaceous species. The tussock grass *Ancistrachne uncinulata* was recorded at a majority of sites and can amount to 5-10% canopy cover. Other tussock grasses included *Aristida* spp., *Paspalidium* spp., *Stipa* spp. and *Eragrostis megalosperma.* Low-creeping grasses included *Calyptochloa gracillima*, and in moister areas, *Oplismenus* spp. and *Panicum* spp. (see **Appendix 2**).

Other graminoids included *Cyperus* spp., *Scleria* spp., *Dianella* spp. and *Lomandra* spp.. Broad-leaved herbs included *Einadia* spp., *Plectranthus parviflorus*, *Brunoniella australis* and *Pseuderanthemum variabile*.

Resurrection ferns are a frequent, though inconspicuous, component of these communities. Common species are *Cheilanthes distans, C. sieberi*, and in more easterly communities, *Doryopteris concolor, Pellaea falcata* var. *nana* and *P. paradoxa.*

Vascular epiphytes were rare except in moister easterly thickets. *Cymbidium canaliculatum* was widespread, but was generally associated with the limbs of hollow emergent trees, such as *Cadellia pentastylis, Eucalyptus* spp. and *Acacia harpophylla.* The most common species within the vine thicket micro-environment were *Dendrobium bowmanii* and *Sarcochilus hillii.* Epiphytes, including the creeping fern *Pyrrosia rupestris*, were often associated with particular host species, e.g. *Planchonella cotinifolia, Canthium vacciniifolium* and *Acalypha eremorum.*

3.5.3 Site attributes

Areas covered by each plot (i.e. plotless sample) ranged from a minimum of 236 m^2 (plot 62C near Mundubbera) up to almost 0.1ha (943 m^2 - plot 53A at Gurulmundi)) (see **Table 3.9**). 93 plots (i.e. 65%) were less than 0.05 ha (500 m^2) in extent.

Table 3.9 Summary of area, topography, slope, aspect and other site attributes for 142 vine thicket plots (75 sites) (see section 3.3.3.2 for abbreviations)

Plot	Area (m^2)	Terrain	Landform Element	Aspect	Slope	Parent Material	Site-group
01A	310	LH/H	L	2	3.0	B	1
01B	324	LH/H	L	2	3.0	B	1
01C	375	LH/H	L	2	3.0	B	1
02A	459	U	L	2	2.0	I	4
02B	619	U	L	2	2.0	I	4
03A	494	U/LH	M	1	4.0	I	4
03B	533	U/LH	M	1	5.0	I	4
04A	435	U/LH	L	1	8.0	S	4
04B	424	U/LH	L	1	6.0	S	4
05A	307	LH/H	L	3	10.0	S	4
06A	393	H	U	1	20.0	I	1
06B	535	H	U	2	20.0	I	1
07A	505	U	F	2	0.5	C	8
07B	559	U	F	2	0.5	C	8
08A	368	U(/LH?)	U	1	3.0	S	8
08B	404	U(/LH?)	U	1	2.0	S	8
09A	640	U(/LH?)	M	1	3.0	S	5
10A	601	LH	L	1	5.0	S	5
10B	611	LH	L	1	4.0	S	5
11A	502	U	F	2	1.0	B	8
11B	359	U	F	2	1.0	B	8
12A	350	U(/LH?)	C	1	4.0	C	8
12B	472	U(/LH?)	C	1	4.0	C	8
13A	610	U(/LH?)	L	2	3.0	C	8
13B	640	U(/LH?)	L	2	3.0	C	8
14A	434	LH	L	3	1.0	B	8
14B	424	LH	L	3	2.0	B	8
15A	355	LH	M	2	3.0	S	5
15B	365	LH	M	2	3.0	S	5
16A	447	LH	M	2	5.0	S	5
16B	480	LH	M	2	7.0	S	5
17A	475	LH	C	2	4.0	S	5
17B	580	LH	C	1	3.0	S	5
18A	657	LH	M	2	5.0	S	5
18B	431	LH	M	2	7.0	S	5
19A	715	U/LH	S	1	5.0	C	4
19B	492	U/LH	S	1	5.0	C	4
20A	589	U/LH	L	2	2.5	A	4
20B	666	U/LH	L	2	3.5	A	4
21A	283	U	C	2	0.5	S	1
21B	429	U	C	2	4.5	S	1
22A	347	LH	M	2	2.0	S	2
22B	485	LH	M	3	5.0	S	2
23A	371	LH	L	2	1.5	S	3
23B	494	LH	L	2	4.5	S	3
24A	421	H/SH	M	2	18.0	I	3
24B	341	H/SH	M	2	20.0	I	3
25A	398	LH	C	3	7.0	I	3
25B	597	LH	C	3	7.0	I	3
26A	654	U/LH	L	2	5.0	I	3
26B	571	U/LH	L	2	3.0	I	3
27A	488	LH	L	2	4.0	I	3
27B	454	LH	L	2	8.0	I	3
28A	772	H/SH	M	2	15.0	A	3
28B	440	H/SH	M	2	15.0	A	3
29A	553	LH	L	2	2.0	I	3
29B	328	LH	L	3	2.0	I	3

Table 3.9 (cont.)

Plot	Area (m^2)	Terrain	Landform Element	Aspect	Slope	Parent Material	Site-group
30A	586	SH	M	2	25.0	I	3
30B	568	SH	M	2	20.0	I	3
31A	825	H/SH	U	2	16.0	B	6
32A	474	U	C	2	0.5	C	8
33A	477	?LH	F	2	1.0	I	5
33B	861	?LH	F	2	1.0	I	5
34A	416	LH	L	2	7.5	S	8
34B	636	LH	L	1	12.5	S	8
35A	564	U/LH	M	2	3.0	S	8
35B	452	U/LH	M	2	4.0	S	8
36A	554	LH	L	3	22.5	S	5
36B	459	LH	L	3	10.5	S	5
37A	424	LH	L	1	5.0	S	5
37B	428	LH	L	1	5.0	S	5
38A	485	U	C	1	3.0	S	8
38B	402	U	C	1	2.5	S	8
39A	650	U	L	3	0.5	S	8
39B	484	U	L	3	0.5	S	8
40A	423	U	F	2	1.0	S	8
40B	476	U	F	2	1.0	S	8
41A	512	H	M	3	9.0	S	8
41B	362	H	M	3	10.0	S	8
42A	571	H	M	2	15.0	B	8
43A	450	U/LH	C	2	0.0	S	8
43B	335	U/LH	C	2	0.0	S	8
44A	548	U	F	2	2.5	C	6
44B	642	U	F	2	3.5	C	6
45A	294	U/LH	L	3	3.0	I	6
45B	400	U/LH	L	3	4.5	I	6
46A	507	LH/H	M	3	9.0	B	3
46B	868	LH/H	M	3	9.0	B	3
47A	905	LH	L	2	12.5	I	6
47B	498	LH	L	2	9.0	I	6
48A	724	H/SH	L	3	17.5	S	7
48B	628	H/SH	L	3	19.0	S	7
49A	382	U/LH	F	3	0.5	S	5
49B	405	U/LH	F	3	1.5	S	5
50A	437	LH	L	2	1.5	S	5
50B	428	LH	L	2	1.5	S	5
51A	556	U/LH	F	3	0.5	S	5
51B	508	U/LH	F	3	0.5	S	5
52A	292	U/LH	F	3	0.5	S	5
52B	335	U/LH	F	3	0.5	S	5
53A	943	LH/H	L	3	1.5	S	8
54A	636	LH/H	L	1	5.0	S	8
55A	598	U	F	3	2.0	S	8
55B	566	U	F	2	1.0	S	8
56A	367	LH/H	L	2	6.0	B	8
57A	421	LH/H	L	2	5.0	S	5
57B	394	LH/H	L	2	5.0	S	5
58A	442	LH/H	F	2	0.5	S	5
59A	324	LH/H	M	2	9.5	I	1
59B	321	LH/H	L	3	6.0	I	1
60A	401	U/LH	L	2	5.0	S	1
60B	324	U/LH	L	2	4.5	S	1
61A	466	U/LH	L	1	6.5	S	1
62A	442	LH	F	2	0.0	S	1
62B	301	LH	L	2	7.5	S	1
62C	236	LH	M	2	7.5	S	1

Table 3.9 (cont.)

Plot	Area (m2)	Terrain	Landform Element	Aspect	Slope	Parent Material	Site-group
63A	707	U/LH	L	2	4.5	S	**5**
63B	654	U/LH	L	2	4.5	S	**5**
64A	347	H	U/M	2	10.0	?I	**1**
64B	297	H	U/M	2	12.5	?I	**1**
65A	403	U/LH	C	2	9.0	S	**4**
65B	346	U/LH	C	2	2.0	S	**4**
66A	552	LH/H	M	1	8.0	B	**4**
66B	372	LH/H	L	3	2.5	B	**4**
67A	353	LH/H	L	1	6.0	I	**3**
67B	528	LH/H	L	2	9.0	I	**3**
68A	430	LH/H	F	1	1.0	S	**1**
68B	411	LH/H	F	1	1.0	S	**1**
69A	351	U	F	2	0.5	S	**1**
69B	341	U	F	2	0.5	S	**1**
70A	417	LH/H	M	2	9.0	S	**1**
70B	446	LH/H	M	2	8.0	S	**1**
71A	524	SH	M	1	28.0	I	**3**
71B	452	SH	M	1	26.0	I	**3**
72A	263	H	U	2	19.0	I	**3**
72B	479	H	U	3	18.0	I	**3**
73A	401	H/SH	M	1	23.0	S/I	**3**
73B	339	H/SH	M	2	13.0	S/I	**3**
73C	326	H/SH	L	2	24.0	S/I	**3**
74A	415	H/SH	M	3	13.0	S	**1**
74B	375	H/SH	M	3	9.0	S	**1**
75A	326	LH	L	2	4.0	B	**1**

Most vine thicket sites were situated on undulating to low-hilly landforms, with only 25 of the 142 plots in areas of more pronounced relief, i.e. hilly to steep-hilly terrain. Of the latter group, three are located in the Springsure district (plots 41A, 41B and 42A), with most found in subcoastal districts.

Vine thickets generally occupy mid- to lower slope positions in the landscape. 116 (82%) of the 142 subplots were found in mid-slope, lower slope and footslope situations (the latter included broad outwash areas). Slope angles measured at the centre of each plot ranged up to almost 30° (71A - Dry Creek, Kroombit Tops), but the slope exceeded 10° for only 25 plots, and most (89 plots) had slopes of 5° or less (**Table 3.9**).

There were no clear preferences for particular aspects, with similar numbers of plots occupying sheltered (category 1) and exposed (category 3) positions (29 and 32 plots respectively). Most plots (81) were intermediate in aspect (category 2).

Vine thickets occurred on a range of parent materials (see **Appendix 4**). At approximately half the sites, the substrate was determined (generally from geological maps) as fine-grained sediments, chiefly siltstone, shale and mudstone. These substrates supported most of the major inland stands of vine thicket, with the balance on basalt and colluvia, alluvia and Tertiary materials.

In the subcoastal districts, vine thickets occurred typically on intermediate and basic volcanics, often interbedded with sediments, including limestone. Metamorphic rocks also supported stands of vine thicket, especially those incorporating metavolcanics. Rock outcrops and scree were frequent, and soils were commonly gravelly.

Soil data are relatively limited. Samples collected during this survey were confined to the upper 10 cm of the soil profile, and little is known of the depth to parent material or trends in colour or texture down the profile. Surface soils ranged in texture from sandy loams to clay loams, and pH values were generally slightly acid to neutral (4.5-7.5). Soil profiles have been described at several vine thicket sites in the Port Curtis and Burnett districts and reference is made to these data in descriptions of the community-types.

As noted above, the impact of grazing animals especially macropods was severe at many sites, with numerous paths and "camps" and browsing of understorey trees and shrubs, e.g. *Canthium vacciniifolium*. Cattle were responsible for widespread trampling damage and associated invasion by pasture grasses. Severe insect defoliation of tree and shrub species including *Planchonella cotinifolia, Excoecaria dallachyana* and *Croton acronychioides* was noted during the latter stages of fieldwork in 1993 and 1994.

Most vine thicket stands had occasional standing dead stems and many trees showed evidence of crown death and coppicing, e.g. *Macropteranthes* spp. and *Backhousia* spp.. In the midst of a severe drought in 1993-94, many larger specimens of *Croton insularis* and *Ehretia membranifolia* were noted as recently dead or dying.

Fallen stems, including emergent *Acacia harpophylla* and *Eucalyptus* spp., were recorded at most sites. Because of the relatively open nature of vine thicket stands, canopy gaps associated with e.g. storm damage were far less obvious than in moister rainforest communities, but evidence of windthrow was noted at several sites.

Old fire scars at Narayen (site 2) and Ka Ka Mundi (site 54) were the only evidence of fire within vine thicket patches.

3.5.4 Vegetation data

3.5.4.1 Biomass/abundance data

Total basal areas ranged from 7.4 to 77.4 m^2 per hectare, with more than half of the plots (79) having basal areas of 25 m^2/ha or less (see **Table 3.10**). Eight plots had basal areas exceeding 50 m^2/ha.

Large basal areas were generally a reflection of the presence of large bottle trees (*Brachychiton* spp.) in the plots - of the 22 trees with diameters of 100 cm or greater (see **Table 3.11**), 18 were *Brachychiton rupestris*, the others being *Brachychiton australis* (3) and *Ficus virens* var. *sublanceolata*. The largest tree recorded in the study was 201 cm in diameter, a specimen of *Brachychiton rupestris* at Zamia Creek in the Taroom district (plot 51B).

Table 3.11 presents the number of stems in each of 5 diameter classes and the maximum diameters recorded for 82 tree species (i.e. those with totals of at least 5 stems).

Most vine thicket trees are relatively small - 70% of the 4500 trees measured in the survey were less than 20 cm in diameter, and only 104 stems (2.3%) were 50 cm or greater (diameters of multiple-stemmed trees were re-calculated for a single-stem equivalent). Apart from *B. rupestris* (43) and *B. australis* (20), the most frequent large tree species was *Cadellia pentastylis* (16). Of the other 15 species reaching 50 cm diameter, only *Acacia harpophylla* (3), *Ficus virens* (2), *Flindersia australis* (3) and *Lysiphyllum hookeri* (5) were recorded more than once.

On ca. 25% (37) of the plots, a single species made up at least one-half of the 32-tree sample (see **Table 3.12**). *Macropteranthes leichhardtii* was dominant in 23 (of a total of 34 plots in which this species was recorded), while other plots were dominated by *Cadellia pentastylis* (4), *Backhousia angustifolia, Macropteranthes leiocaulis* (3 plots each), *Backhousia kingii* (2) and *Acacia catenulata* and *Bosistoa medicinalis* (1 each). A further 17 species had relative densities of 25-50% in at least one plot (see **Table 3.12**).

Table 3.10. Basal areas, stem densities and numbers of tree species for 142 vine thicket plots.

Group	Plot	Area (m^2)	Adj. area* (m^2)	Basal area (m^2)	Basal area (m^2/ha)	Trees /ha	Tall shrubs (>3m)	Tall shrubs /ha	Trees + shrubs /ha	Tree species
1	01A	310.1	337.7	1.054	31.2	948	56	1806	2753	17
1	01B	324.0	352.8	1.637	46.4	907				15
1	01C	375.0	408.4	1.507	36.9	784				18
4	02A	458.6	499.4	1.957	39.2	641	44	959	1600	12
4	02B	618.9	674.0	1.162	17.2	475	63	1018	1493	11
4	03A	493.9	537.9	2.550	47.4	595	45	911	1506	8
4	03B	532.7	580.1	2.389	41.2	552	51	957	1509	13
4	04A	434.5	473.2	1.213	25.6	676	30	690	1367	10
4	04B	424.3	462.1	1.181	25.6	693	34	801	1494	9
4	05A	306.7	334.0	1.003	30.0	958	41	1337	2295	19
1	06A	393.1	428.1	1.115	26.0	748	48	1221	1969	13
1	06B	534.5	582.1	1.346	23.1	550	25	468	1017	13
8	07A	505.0	549.9	1.146	20.8	582	164	3248	3829	10
8	07B	558.7	608.4	0.605	9.9	526	183	3275	3801	7
8	08A	368.1	400.9	0.638	15.9	798	108	2934	3732	5
8	08B	403.5	439.4	0.689	15.7	728	72	1784	2513	7
5	09A	640.0	697.0	0.950	13.6	459	95	1484	1944	12
5	10A	601.3	654.8	1.008	15.4	489	105	1746	2235	6
5	10B	610.8	665.2	1.057	15.9	481	85	1392	1873	7
8	11A	501.5	546.1	0.744	13.6	586	39	778	1364	5
8	11B	358.6	390.5	0.590	15.1	819	28	781	1600	4
8	12A	350.4	381.6	0.775	20.3	839	48	1370	2208	4
8	12B	471.8	513.8	0.955	18.6	623	90	1908	2530	6
8	13A	609.6	663.9	2.021	30.4	482	125	2051	2533	10
8	13B	640.1	697.1	1.380	19.8	459	32	500	959	8
8	14A	433.6	472.2	1.980	41.9	678	73	1684	2361	9
8	14B	423.6	461.3	0.906	19.6	694	74	1747	2441	7
5	15A	354.5	386.1	1.033	26.7	829	65	1834	2662	9
5	15B	364.8	397.3	0.925	23.3	806	65	1782	2587	11
5	16A	447.1	486.9	1.002	20.6	657	65	1454	2111	14
5	16B	479.6	522.3	2.830	54.2	613	70	1460	2072	14
5	17A	474.7	516.9	1.767	34.2	619	84	1770	2389	9
5	17B	580.1	631.7	2.311	36.6	507	85	1465	1972	10
5	18A	656.7	715.1	1.239	17.3	447	124	1888	2336	15
5	18B	430.7	469.0	1.230	26.2	682				17
4	19A	714.5	778.1	2.581	33.2	411	62	868	1279	13
4	19B	492.4	536.2	1.314	24.5	597				16
4	20A	589.3	641.7	0.789	12.3	499				16
4	20B	666.4	725.7	1.197	16.5	441				16
1	21A	283.2	308.4	1.114	36.1	1038				14
1	21B	428.6	466.7	1.130	24.2	686				15
2	22A	347.2	378.1	1.017	26.9	846	40	1152	1998	10
2	22B	485.0	528.2	1.049	19.9	606	105	2165	2771	15
3	23A	370.7	403.7	0.596	14.8	793	133	3588	4380	6
3	23B	493.7	537.6	0.801	14.9	595				15
3	24A	420.7	458.1	0.976	21.3	698	52	1236	1935	15
3	24B	341.4	371.8	0.955	25.7	861				9
3	25A	398.0	433.4	0.932	21.5	738	51	1281	2020	16
3	25B	597.1	650.2	2.377	36.6	492				16
3	26A	653.7	711.9	0.894	12.6	450	123	1882	2331	13
3	26B	571.3	622.1	0.705	11.3	514	130	2276	2790	15

* Adjusted area = 1.089 x area

Table 3.10 (cont.)

Group	Plot	Area (m^2)	Adj. area* (m^2)	Basal area (m^2)	Basal area (m^2/ha)	Trees /ha	Tall shrubs (>3m)	Tall shrubs /ha	Trees + shrubs /ha	Tree species
3	27A	488.0	531.4	1.419	26.7	602	123	2520	3123	16
3	27B	454.4	494.8	0.933	18.8	647				14
3	28A	771.7	840.4	1.147	13.6	381	93	1205	1586	11
3	28B	439.5	478.6	1.729	36.1	669	68	1547	2216	14
3	29A	552.5	601.7	0.695	11.6	532	139	2516	3048	10
3	29B	328.3	357.5	0.517	14.5	895				12
3	30A	586.1	638.3	1.251	19.6	501	50	853	1354	8
3	30B	567.6	618.1	0.980	15.8	518	81	1427	1945	8
6	31A	825.4	898.9	2.095	23.3	356	76	921	1277	12
8	32A	473.5	515.6	0.803	15.6	621	49	1035	1655	6
5	33A	476.7	519.1	1.295	24.9	616	48	1007	1623	15
5	33B	860.9	937.5	1.338	14.3	341				16
8	34A	416.0	453.0	1.672	36.9	706	35	841	1548	7
8	34B	636.1	692.7	2.256	32.6	462	69	1085	1547	9
8	35A	563.5	613.7	1.099	17.9	521	72	1278	1799	3
8	35B	451.8	492.0	0.697	14.2	650				4
5	36A	554.3	603.6	2.325	38.5	530	90	1624	2154	11
5	36B	458.8	499.6	1.306	26.1	640				11
5	37A	423.8	461.5	1.182	25.6	693	36	849	1543	11
5	37B	427.7	465.8	1.800	38.6	687	22	514	1201	10
8	38A	485.2	528.4	1.468	27.8	606	88	1814	2419	7
8	38B	402.0	437.8	0.777	17.7	731				8
8	39A	649.6	707.4	2.054	29.0	452	120	1847	2300	12
8	39B	483.9	527.0	1.215	23.1	607				12
8	40A	422.7	460.3	0.900	19.6	695	33	781	1476	8
8	40B	476.4	518.8	1.390	26.8	617				8
8	41A	511.9	557.5	1.692	30.3	574	30	586	1160	7
8	41B	362.1	394.3	0.912	23.1	812				9
8	42A	570.5	621.3	0.895	14.4	515				8
8	43A	450.4	490.5	0.517	10.5	652	41	910	1563	1
8	43B	334.6	364.4	0.466	12.8	878				2
6	44A	547.7	596.4	1.277	21.4	537	35	639	1176	7
6	44B	641.7	698.8	1.096	15.7	458				10
6	45A	293.5	319.6	0.944	29.5	1001	40	1363	2364	9
6	45B	399.8	435.4	0.770	17.7	735				9
3	46A	506.7	551.8	3.503	63.5	580	59	1164	1744	11
3	46B	867.6	944.8	3.064	32.4	339				13
6	47A	905.3	985.9	2.161	21.9	325				11
6	47B	497.8	542.1	1.061	19.6	590				11
7	48A	723.5	787.9	0.585	7.4	406	63	871	1277	4
7	48B	627.7	683.6	0.606	8.9	468				6
5	49A	381.8	415.8	1.041	25.0	770	28	733	1503	15
5	49B	404.8	440.8	1.622	36.8	726				15
5	50A	436.5	475.3	1.096	23.1	673	57	1306	1979	9
5	50B	428.3	466.4	1.260	27.0	686				11
5	51A	556.1	605.6	1.845	30.5	528	36	647	1176	11
5	51B	507.5	552.7	4.276	77.4	579				10
5	52A	292.0	318.0	2.132	67.0	1006	45	1541	2547	11
5	52B	335.0	364.8	0.773	21.2	877				10
8	53A	943.0	1026.9	3.767	36.7	312				8

*** Adjusted area = 1.089 x area**

Table 3.10 (cont.)

Group	Plot	Area (m^2)	Adj. area* (m^2)	Basal area (m^2)	Basal area (m^2/ha)	Trees /ha	Tall shrubs (>3m)	Tall shrubs /ha	Trees + shrubs /ha	Tree species
5	52B	335.0	364.8	0.773	21.2	877				10
8	53A	943.0	1026.9	3.767	36.7	312				8
8	54A	635.9	692.5	0.930	13.4	462				6
8	55A	598.3	651.5	1.398	21.5	491	63	1053	1544	5
8	55B	565.7	616.0	2.201	35.7	519				8
8	56A	367.3	400.0	2.071	51.8	800	34	926	1726	7
5	57A	420.5	457.9	0.623	13.6	699	63	1498	2197	11
5	57B	394.4	429.5	0.736	17.1	745	50	1268	2013	11
5	58A	442.2	481.6	3.541	73.5	665	23	520	1185	15
1	59A	324.3	353.2	0.954	27.0	906				11
1	59B	321.0	349.6	0.941	26.9	915	121	3769	4685	18
1	60A	400.5	436.1	1.202	27.6	734	50	1248	1982	9
1	60B	323.9	352.7	0.729	20.7	907	38	1173	2080	11
1	61A	466.4	507.9	1.345	26.5	630	57	1222	1852	14
1	62A	442.1	481.4	1.166	24.2	665	127	2873	3537	10
1	62B	300.9	327.7	1.198	36.6	977	73	2426	3403	14
1	62C	235.9	256.9	0.823	32.0	1246	66	2798	4043	11
5	63A	706.9	769.8	1.391	18.1	416	27	382	798	10
5	63B	654.3	712.5	0.664	9.3	449				10
4	64A	347.3	378.2	0.661	17.5	846	73	2102	2948	16
1	64B	297.3	323.8	0.856	26.4	988	61	2052	3040	15
4	65A	403.1	439.0	1.189	27.1	729	44	1092	1821	16
4	65B	345.8	376.6	0.959	25.5	850	51	1475	2325	18
4	66A	552.1	601.2	0.698	11.6	532	100	1811	2344	14
4	66B	372.1	405.2	2.542	62.7	790	95	2553	3343	6
3	67A	352.8	384.2	0.763	19.9	833	130	3685	4518	12
3	67B	527.5	574.4	0.521	9.1	557				13
1	68A	429.8	468.1	1.420	30.3	684	113	2629	3313	12
1	68B	410.8	447.4	1.491	33.3	715				16
1	69A	350.5	381.7	1.416	37.1	838				14
1	69B	341.3	371.7	0.765	20.6	861				13
1	70A	416.9	454.0	1.529	33.7	705	70	1679	2384	16
1	70B	445.9	485.6	1.032	21.2	659				13
3	71A	524.4	571.1	0.733	12.8	560	153	2918	3478	9
3	71B	452.3	492.6	3.759	76.3	650	91	2012	2662	9
3	72A	263.3	286.7	0.545	19.0	1116	42	1595	2711	6
3	72B	479.2	521.8	0.931	17.8	613				14
3	73A	400.7	436.4	1.001	22.9	733	55	1373	2106	13
3	73B	339.3	369.5	0.673	18.2	866				12
3	73C	325.8	354.8	1.301	36.7	902				14
1	74A	414.5	451.4	0.816	18.1	709	124	2992	3700	16
1	74B	375.2	408.6	0.939	23.0	783				14
1	75A	326.2	355.2	1.629	45.9	901	97	2974	3874	14

*** Adjusted area = 1.089 x area**

Densities (counts per hectare) of trees and tall shrubs (≥3 m in height) ranged from 895 (plot 63A) to 4766 (plot 59B). Of the 96 plots for which these data were collected, 4 had densities

>4000/ha, 14 3000-4000/ha, 39 2000-3000/ha and 38 1000-2000/ha (see **Table 3.10**). Although most of the higher counts (i.e. >3000/ha) were made in the subcoastal vine thickets, there were also three counts of >3800/ha in the eastern *Macropteranthes leichhardtii* stands (plots 7A, 7B and 8A).

Table 3.11 Numbers of stems in diameter classes and largest stems - vine thicket trees.

Namecode*	Diameter#					Total	Max. diam. (cm)	Namecode	Diameter					Total	Max. diam. (cm)
	D1	D2	D3	D4	D5				D1	D2	D3	D4	D5		
ACACCATE	15	7	4	0	0	26	36.9	DRYPAUST	23	3	0	0	0	26	26.6
ACACFASC	60	40	9	0	0	109	45.7	EHREMEMB	76	21	5	0	0	102	36.6
ACACHARP	12	10	12	3	0	37	59.5	ELATXYLO	35	4	0	0	0	39	29.5
ALECCONN	18	4	0	0	0	22	25.0	ERYTAUST	22	2	1	0	0	25	30.2
ALECDIVE	54	4	0	0	0	58	28.8	EUROFALC	2	2	0	1	0	5	58.5
ALECPUBE	12	1	0	0	0	13	22.4	EXCODALL	203	35	2	0	0	240	32.4
ALECSUBD	13	2	0	0	0	15	23.1	EXOCLATI	13	2	0	0	0	15	22.4
ALSTCONS	8	1	0	0	0	9	24.7	FICUPLAT	0	2	3	0	0	5	47.0
APOPANOM	14	3	1	0	0	18	30.4	FLINAUST	8	8	6	3	0	25	95.0
ARCHTHOZ	35	20	10	0	0	65	47.5	FLINCOLL	40	17	5	1	0	63	53.0
ARYTFOVE	19	1	0	0	0	20	26.2	FONTVENO	6	0	0	0	0	6	17.1
ARYTMICR	9	1	0	0	0	10	20.0	GEIJPANI	70	22	5	1	0	98	60.8
ATALMULT	5	1	0	0	0	6	20.3	GEIJPARV	55	40	13	0	0	108	40.5
ATALSALI	52	6	4	0	0	62	33.3	GEIJSALA	6	18	2	0	0	26	46.6
AUSTBIDW	87	2	0	0	0	89	24.5	GEIJSASA	11	19	5	0	0	35	43.9
BACKANGU	160	29	1	0	0	190	43.2	GREVHELM	27	5	1	0	0	33	31.1
BACKKING	99	15	2	0	0	116	41.4	GUETPUTA	13	0	0	0	0	13	18.0
BARKSYRI	4	2	0	0	0	6	26.6	GYROAMER	24	8	4	0	0	36	43.1
BOSIMEDI	28	7	0	0	0	35	29.7	HOMAALNI	3	2	3	0	0	8	38.3
BRACAUST	11	4	12	17	3	47	106.0	LYSICARR	1	1	2	1	0	5	55.3
BRACRUPE	6	4	9	25	18	62	201.0	LYSIHOOK	15	19	10	5	0	49	63.1
BRIELEIC	22	6	2	0	0	30	38.1	MACRLEIC	530	95	13	0	0	638	37.2
BURSINCA	17	1	0	0	0	18	24.9	MACRLEIO	83	10	4	0	0	97	32.6
CADEPENT	50	41	21	16	0	128	94.0	MAYTDISP	10	3	0	0	0	13	22.7
CANTBRIG	15	1	0	0	0	16	21.0	MELIERYT	42	15	1	0	0	58	35.4
CANTODOR	15	0	0	0	0	15	15.6	NOTEMICR	103	59	12	0	0	174	36.5
CAPPARBO	32	17	1	0	0	50	30.1	OPUNTOME	3	1	1	0	0	5	35.0
CAPPLORA	30	4	0	0	0	34	23.2	OWENVENO	54	31	15	1	0	101	51.8
CAPPMITC	4	2	0	0	0	6	24.7	PENTAUST	9	0	0	0	0	9	17.0
CASSAUAN	30	3	0	0	0	33	23.2	PITTRHOM	5	1	0	0	0	6	23.0
CASSAUAU	7	1	0	0	0	8	22.1	PLANCOCO	33	11	4	0	0	48	43.8
CASSBREW	5	4	0	0	0	9	24.5	PLANCOPU	219	143	43	1	0	406	53.6
CASUCRIS	6	13	6	1	0	26	55.2	PLEITIMO	6	8	11	1	0	26	82.6
CROTINSU	86	0	0	0	0	86	17.9	POLYELEG	7	2	0	0	0	9	20.9
CUPAPARV	21	21	3	0	0	45	35.5	PREMLIGN	1	4	7	0	0	12	49.7
DENDPHOT	6	6	4	0	0	16	40.5	SIPHAUST	12	5	1	0	0	18	33.7
DENHOLEA	13	3	1	0	0	17	30.1	STERQUAD	2	9	3	0	0	14	32.9
DENHPARV	6	0	0	0	0	6	16.3	STRYAXIL	52	14	0	0	0	66	26.4
DENHPITT	25	11	1	0	0	37	42.9	TERMOBLO	9	12	3	0	0	24	37.2
DIOSGEMI	25	3	0	0	0	28	26.0	TERMPORP	3	5	2	0	0	10	35.1
DIOSHUMI	109	10	0	1	0	120	66.1	VENTVIMI	6	3	2	1	0	12	56.6

 # Diameter Classes **D1 = 10.0-19.9cm** **D3 = 30.0-49.9cm** **D5 = 100cm+**
D2 = 20.0-29.9cm **D4 = 50.0-99.9cm**

*** For list of species codes and scientific names, see Appendix 2.**

Thirty-one tree species had canopy covers of 25% or greater in at least one plot (see **Table 3.13**). They included the large emergents *Archidendropsis thozetiana, Brachychiton australis* and *B. rupestris*. The results for *Macropteranthes leichhardtii* further emphasise its abundance - in only two of the 34 plots where it was recorded was its total cover less than 25%.

Altogether 131 tree species (i.e. represented on at least one plot by a stem ≥10 cm diameter at breast height) were recorded from the 142 plots (see Table **3.10**). Numbers of species per plot ranged from one only - *Macropteranthes leichhardtii* - on plot 43A near Emerald to 19 (plot 5A north of Chinchilla). Ten plots had 5 species or fewer, while 92 (65%) had 10 or more tree species. Of the latter, 30 were particularly diverse, with 15 or more species in each 32-tree sample.

Table 3.12 Vine thicket tree species with relative densities of 25% or greater.

	Relative Density Class				
Species	**1 (<25%)**	**2 (25-50%)**	**3 (50-75%)**	**4 (75-100%)**	**No. of Plots**
ACACCATE	0	1	1	0	2
ACACHARP	15	1	0	0	16
AUSTBIDW	32	1	0	0	33
BACKANGU	23	6	3	0	32
BACKKING	8	4	1	1	14
BOSIMEDI	3	0	1	0	4
CADEPENT	7	3	4	0	14
CASSBREW	0	1	0	0	1
CROTINSU	37	1	0	0	38
CUPAPARV	9	1	0	0	10
DIOSHUMI	52	1	0	0	53
EHREMEMB	54	1	0	0	55
EXCODALL	40	8	0	0	48
GEIJPANI	20	3	0	0	23
GEIJPARV	30	3	0	0	33
GYROAMER	10	1	0	0	11
LYSIHOOK	16	1	0	0	17
MACRLEIC	3	8	15	8	34
MACRLEIO	5	0	0	3	8
NOTEMICR	66	4	0	0	70
PLANCOCO	22	1	0	0	23
PLANCOPU	87	10	0	0	97
STRYAXIL	21	1	0	0	22
TERMOBLO	6	1	0	0	7

One-half of the species (66) were recorded from 5 or fewer plots, with 31 recorded once only. Twenty-six species occurred in 20 or more plots, with four (*Diospyros humilis, Ehretia membranifolia, Notelaea microcarpa* and *Planchonella cotinifolia* in more than 50 plots. Frequency and diversity of canopy and other vine thicket species (based on cover data) are discussed further in sections **3.5.4.2** and **3.5.5** below.

Table 3.13 Records of tree species with crown covers of 25% or greater in 133 vine thicket plots.

	Number of Plots							
Cover Class	1 (<1%)	2 (1-5%)	3 (5-10%)	4 (10-25%)	5 (25-50%)	6 (50-75%)	7 (>75%)	Total Plots
ACACCATE	0	0	0	0	2	0	0	2
ARCHTHOZ	1	6	6	7	3	0	0	23
AUSTBIDW	19	18	18	5	1	0	0	61
BACKANGU	8	16	5	5	7	1	0	42
BACKKING	1	5	0	5	4	2	0	17
BOSIMEDI	1	0	1	1	2	0	0	5
BRACAUST	10	11	11	4	0	1	0	37
BRACRUPE	10	11	16	15	2	0	0	54
CADEPENT	0	1	1	3	8	1	0	14
CASSBREW	0	0	0	0	1	0	0	1
CASUCRIS	0	2	1	5	1	0	0	9
CROTINSU	7	30	18	23	10	1	0	89
CUPAPARV	5	2	3	3	2	0	0	15
EXCODALL	3	10	10	17	8	0	0	48
FICUPLAT	2	0	2	1	1	0	0	6
FLINAUST	2	6	6	4	2	0	0	20
GEIJPANI	1	8	2	9	3	0	0	23
GEIJPARV	16	10	14	12	2	0	0	54
GREVHELM	5	13	4	1	1	0	0	24
GYROAMER	0	7	1	1	1	0	0	10
LYSIHOOK	1	3	5	8	1	0	0	18
MACRLEIC	0	1	1	0	20	11	1	34
MACRLEIO	1	1	1	3	0	3	0	9
NOTEMICR	33	45	18	5	2	0	0	103
OWENVENO	6	7	8	10	8	0	0	39
PENTAUST	0	0	0	1	1	0	0	2
PLANCOPU	1	23	29	38	9	0	0	100
STRYAXIL	9	13	10	10	3	0	0	45
TERMOBLO	0	2	2	2	1	0	0	7

3.5.4.2 Frequency of vine thicket species

Cover data were collected from 133 of the 142 plots for all tree and shrub species, together with the strata in which they occurred, i.e. canopy (≥10 cm dbh), tall shrub/low tree (≥3 m height) and low shrub layers. The data set also includes emergent trees (mostly *Brachychiton* spp.) whose canopies overhung plots, although they were not amongst the 32-nearest tree samples. Altogether 187 species were recorded, of which 82 (i.e. 45%) occurred in 5 plots or fewer (see **Figure 3.7**). Twenty-two species occurred in 50 or more plots

The most widely distributed and frequent taxon recorded during this study was the low shrub *Carissa ovata*, which was present in 115 plots (i.e. 86.5% frequency) (see **Table 3.14**).

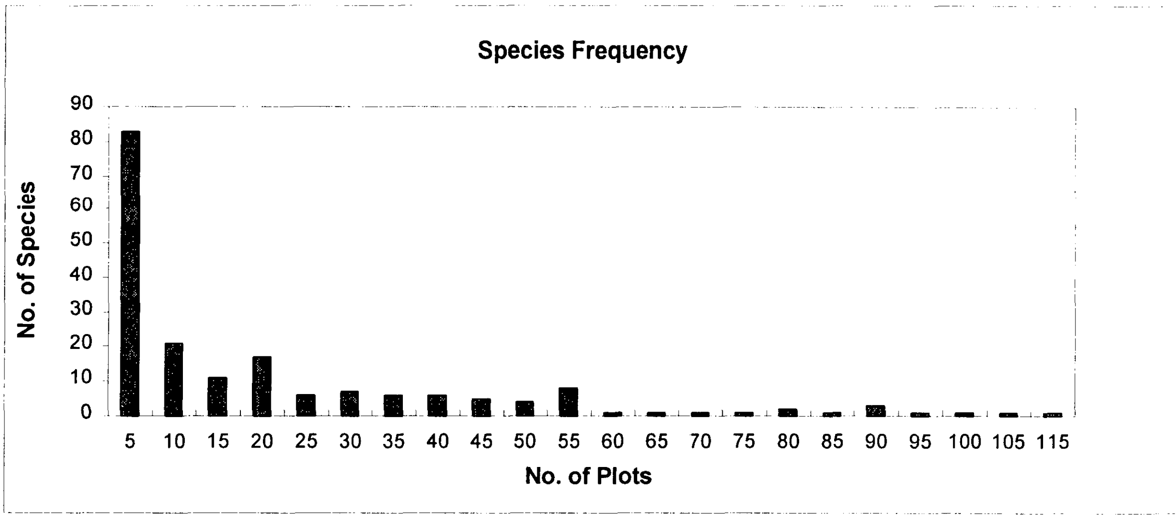


Figure 3.7 Histogram of species frequency based on cover data from 133 vine thicket plots

Table 3.14 Vine thicket species occurring in 34 or more plots (i.e. a frequency of >25%)

Species	Life Form	Plots	Species	Life Form	Plots	Species	Life Form	Plots
CARIOVAT	s	115	JASMSIAU	v	60	STRYAXIL	t	45
NOTEMICR	t	103	TURRPUBE	s	58	CROTPHEB	s	44
PLANCOPU	t	100	BRACRUPE	t	54	DIOSGEMI	t	43
CITRSPIN	s	95	GEIJPARV	t	54	DIOSTRAN	v	43
SECAELLI	v	92	ACACFASC	t	52	BACKANGU	t	42
CROTINSU	t	89	CAPPLORA	t	52	MELOLEIC	v	42
DIOSHUMI	t	88	FLINCOLL	t	52	ALSTCONS	t	40
CISSOPAC	v	87	GLOSHEMI	v	52	OPUNTOME	t	40
ACALEREM	s	86	ATALSALI	t	51	OWENVENO	t	39
EHREMEMB	t	81	BREYOBLO	s	51	DENHPITT	t	38
DIPLIXOR	s	79	ERYTAUST	t	51	ALYXRUSC	s	37
ALECDIVE	t	76	ALECCONN	t	50	BRACAUST	t	37
CANTODOR	t	75	TINOSMIL	v	50	CAPPLASI	v	36
JASMDIRA	v	75	DRYPDEPL	t	48	CYNABOWM	v	36
CANTVACC	s	69	ELATXYLO	t	48	CASSAUAN	t	35
PARSLANC	v	69	EXCODALL	t	48	MACRLEIC	t	34
AUSTBIDW	t	61	CAPPARBO	t	45	MALASCAN	v	34

The most frequent canopy species was *Notelaea microcarpa* (103 plots/77.4%). *Planchonella cotinifolia* var. *pubescens* (100 plots/75.2%) and *P. cotinifolia* var. *cotinifolia* (17 plots) contributed to a total frequency of 88% for this subcanopy species.

Other frequent low tree species included *Croton insularis* (89/66.9%), *Diospyros humilis* (88/66.2%), *Ehretia membranifolia* (81/60.9%) and *Canthium odoratum* (75/56.4%). The shrub species *Citriobatus spinescens* (95/71.4%), *Acalypha eremorum* (86/64.7%), *Diplospora ixoroides* (79/59.4%) and *Canthium vacciniifolium* (69/51.9%) were also present in a majority of the plots.

(79/59.4%) and *Canthium vacciniifolium* (69/51.9%) were also present in a majority of the plots.

Of the subshrub and ground cover species, the most widespread and frequent were the grass *Ancistrachne uncinulata* (103/77.4%) and the subshrubs *Abutilon oxycarpum* forma *acutatum* (83/62.4%) and *Spartothamnella juncea* (80/60.1%).

The vine *Secamone elliptica* was recorded in 92 plots (69.2% frequency) and *Cissus opaca* in 87 (66.1%), while *Parsonsia lanceolata* (69/51.9%) and *Jasminum didymum* subsp. *racemosum* also occurred in more than 50% of the plots (see **Table 3.14**). Several other vine species were relatively frequent in subcoastal habitats (e.g. *Melodorum leichhardtii, Malaisia scandens*) with a few (e.g. *Capparis lasiantha, Jasminum didymum* subsp. *lineare*) preferring more inland vine thicket habitats.

Alien plant species were relatively uncommon in the larger and more intact vine thicket remnants, although grasses such as *Cenchrus ciliaris* and *Panicum maximum* var. *trichoglume* and several vine species were locally prominent in disturbed situations. The most frequent alien species recorded during the survey was velvety tree pear (*Opuntia tomentosa*) (40 plots, i.e. 30%), which was widespread in the inland vine thickets. The next most frequent was the vine *Solanum seaforthianum* which occurred in 26 plots (19.5%), mostly in subcoastal districts. *Lantana camara* occurred in 20 plots, all in relatively moist subcoastal sites.

3.5.5 Species richness and evenness

The most frequently used and simple index of diversity is species richness, i.e. the number of species recorded per sample or community. Other indices combine species richness and relative abundance of species within the sample or community, and probably the most widely used of these is the Shannon diversity index (or Shannon-Wiener index) (Kent and Coker 1992). The Shannon index is calculated from the formula:

$$\textbf{Diversity}\ (H') = -\sum_{i=1}^{s} p_i \ln p_i$$

where s = number of species, p_i = cover of the ith species as a proportion of total cover and ln = log base$_n$

and

$$\textbf{Equitability}\ (\text{evenness})\ (J') = \frac{H'}{\ln s}\ .$$

Table **3.15** presents the counts of trees, shrubs, subshrubs and vines for 136 vine thicket plots, together with their diversity and evenness indices.

Table 3.15 Species counts, diversity and evenness measures for 136 vine thicket plots

Plot	Tree layer	Tall shrub layer[1]	T+S layers	Low shrub layer[2]	T+S+L layers	Sub-shrub layer	T+S+L + SS layers	Vine spp.	TOTAL SPECIES	Shannon Diversity Index (H')	Evenness (J')
01A	**17**	14	31	11	42	5	47	17	**64**	3.049	0.8157
01B	**15**	14	29	13	42	3	45	12	**57**	n.a.	n.a.
01C	**18**	9	27	13	40	4	44	11	**55**	n.a.	n.a.
02A	**12**	10	22	11	33	4	37	8	**45**	2.842	0.8129
02B	**11**	10	21	5	26	2	28	10	**38**	2.833	0.8696
03A	**8**	8	16	3	19	5	24	5	**29**	2.415	0.8203
03B	**13**	7	20	1	21	4	25	5	**30**	2.753	0.9041
04A	**11**	10	21	4	25	3	28	3	**31**	2.589	0.8044
04B	**9**	6	15	9	24	4	28	6	**34**	2.488	0.7829
05A	**20**	11	31	9	40	5	45	12	**57**	3.114	0.8440
06A	**13**	10	23	7	30	2	32	9	**41**	2.578	0.7578
06B	**14**	9	23	3	26	2	28	11	**39**	2.436	0.7478
07A	**10**	5	15	5	20	3	23	6	**29**	2.211	0.7379
07B	**7**	5	12	2	14	4	18	4	**22**	1.941	0.7354
08A	**5**	8	13	3	16	2	18	5	**23**	2.045	0.7377
08B	**7**	8	15	3	18	4	22	3	**25**	2.064	0.7141
09A	**12**	16	28	4	32	2	34	6	**40**	3.003	0.8666
10A	**6**	5	11	7	18	1	19	6	**25**	2.220	0.7681
10B	**7**	7	14	5	19	2	21	6	**27**	2.196	0.7460
11A	**5**	2	7	6	13	5	18	7	**25**	1.501	0.5852
11B	**4**	5	9	3	12	2	14	5	**19**	1.414	0.5691
12A	**4**	6	10	6	16	5	21	6	**27**	1.672	0.6032
12B	**6**	6	12	5	17	1	18	6	**24**	1.821	0.6427
13A	**10**	6	16	2	18	4	22	4	**26**	2.085	0.7212
13B	**8**	8	16	2	18	4	22	4	**26**	1.929	0.6673
14A	**9**	5	14	4	18	4	22	5	**27**	2.076	0.7183
14B	**8**	7	15	7	22	2	24	6	**30**	2.251	0.7282
15A	**9**	15	24	5	29	6	35	12	**47**	2.574	0.7644
15B	**11**	11	22	9	31	5	36	11	**47**	2.665	0.7762
16A	**14**	8	22	6	28	6	34	11	**45**	2.698	0.8097
16B	**14**	7	21	3	24	5	29	8	**37**	2.748	0.8646
17A	**9**	7	16	7	23	8	31	10	**41**	2.300	0.7334
17B	**10**	8	18	8	26	5	31	10	**41**	2.464	0.7561
18A	**15**	11	26	5	31	6	37	13	**50**	2.558	0.7450
19A	**13**	12	25	3	28	4	32	8	**40**	2.508	0.7527
20A	**16**	8	24	12	36	6	42	13	**55**	2.910	0.8120
20B	**16**	5	21	7	28	7	35	12	**47**	2.798	0.8398
21A	**14**	5	19	11	30	4	34	11	**45**	2.459	0.7231
21B	**15**	9	24	9	33	4	37	14	**51**	2.542	0.7270
22A	**10**	14	24	14	38	5	43	17	**60**	2.661	0.7314
22B	**15**	15	30	11	41	6	47	17	**64**	2.756	0.7422
23A	**6**	12	18	9	27	3	30	15	**45**	2.531	0.7679
23B	**15**	17	32	5	37	2	39	14	**53**	2.870	0.7948
24A	**15**	12	27	4	31	1	32	16	**48**	3.129	0.9112
25A	**16**	10	26	4	30	2	32	12	**44**	2.845	0.8366
26A	**13**	17	30	9	39	4	43	12	**55**	2.871	0.7835
26B	**15**	17	32	10	42	2	44	9	**53**	3.225	0.8629

[1] **Includes tree species not represented in tree layer.**

[2] **Includes tree and tall shrub species not represented in tree and tall shrub layers.**

Table 3.15 (cont.)

Plot	Tree layer	Tall shrub layer[1]	T+S layers	Low shrub layer[2]	T+S+L layers	Sub-shrub layer	T+S+L + SS layers	Vine spp.	TOTAL SPECIES	Shannon Diversity Index (H')	Evenness (J')
27A	**16**	13	29	7	36	3	39	14	**53**	2.873	0.8016
27B	**14**	10	24	10	34	3	37	10	**47**	2.875	0.8152
28A	**11**	14	25	5	30	3	33	16	**49**	2.583	0.7594
28B	**14**	8	22	5	27	4	31	13	**44**	2.651	0.8042
29A	**10**	19	29	8	37	8	45	10	**55**	2.866	0.7879
30A	**8**	7	15	2	17	5	22	8	**30**	2.246	0.7927
30B	**9**	13	22	2	24	5	29	12	**41**	2.489	0.7831
31A	**13**	11	24	9	33	4	37	10	**47**	2.826	0.8083
32A	**6**	1	7	6	13	4	17	5	**22**	1.755	0.6843
33A	**15**	12	27	7	34	6	40	13	**53**	2.737	0.7761
34A	**7**	6	13	5	18	5	23	6	**29**	2.032	0.7029
34B	**9**	9	18	7	25	5	30	5	**35**	2.212	0.6870
35A	**3**	0	3	3	6	0	6	2	**8**	1.027	0.5733
35B	**4**	2	6	1	7	3	10	2	**12**	1.271	0.6533
36A	**11**	9	20	8	28	6	34	11	**45**	2.632	0.7898
36B	**11**	5	16	9	25	5	30	7	**37**	n.a.	n.a.
37A	**13**	5	18	13	31	5	36	10	**46**	2.437	0.7097
37B	**11**	4	15	7	22	5	27	2	**29**	2.135	0.6907
38A	**7**	7	14	2	16	4	20	7	**27**	1.943	0.7009
38B	**8**	2	10	6	16	2	18	7	**25**	1.969	0.7100
39A	**12**	8	20	7	27	2	29	8	**37**	2.485	0.7540
39B	**12**	6	18	6	24	3	27	5	**32**	2.530	0.7962
40A	**8**	6	14	8	22	4	26	10	**36**	1.814	0.5869
40B	**8**	3	11	7	18	3	21	8	**29**	2.107	0.7291
41A	**7**	5	12	10	22	8	30	10	**40**	2.096	0.6780
41B	**9**	0	9	10	19	9	28	9	**37**	2.083	0.7073
42A	**8**	2	10	11	21	6	27	7	**34**	1.904	0.6253
43A	**1**	1	2	1	3	3	6	2	**8**	0.179	0.1627
43B	**2**	3	5	1	6	3	9	3	**12**	0.815	0.4547
44A	**7**	7	14	6	20	2	22	5	**27**	2.341	0.7815
44B	**10**	7	17	8	25		25	4	**29**	2.328	0.7232
45A	**9**	10	19	6	25	2	27	7	**34**	2.330	0.7240
45B	**9**	6	15	8	23	1	24	6	**30**	2.029	0.6471
46A	**11**	9	20	8	28	4	32	12	**44**	2.403	0.7211
46B	**13**	3	16	7	23	3	26	10	**36**	2.632	0.8394
47A	**11**	9	20	5	25	2	27	11	**38**	1.957	0.6079
47B	**11**	9	20	5	25	1	26	5	**31**	2.146	0.6667
48A	**4**	3	7	9	16	0	16	5	**21**	1.499	0.5407
48B	**6**	3	9	6	15	1	16	5	**21**	1.416	0.5230
49A	**15**	10	25	2	27	7	34	7	**41**	2.474	0.7507
49B	**15**	9	24	6	30	6	36	9	**45**	2.449	0.7199
50A	**9**	3	12	8	20	6	26	7	**33**	2.323	0.7754
50B	**11**	3	14	7	21	6	27	5	**32**	2.156	0.7081
51A	**11**	5	16	3	19	9	28	3	**31**	2.276	0.7730
51B	**10**	5	15	6	21	5	26	2	**28**	2.296	0.7541

[1] Includes tree species not represented in tree layer.

[2] Includes tree and tall shrub species not represented in tree and tall shrub layers.

Table 3.15 (cont.)

Plot	Tree layer	Tall shrub layer[1]	T+S layers	Low shrub layer[2]	T+S+L layers	Sub-shrub layer	T+S+L + SS layers	Vine spp.	TOTAL SPECIES	Shannon Diversity Index (H')	Evenness (J')
52A	**11**	4	15	10	25	3	28	5	**33**	2.339	0.7266
52B	**10**	4	14	13	27	5	32	7	**39**	2.416	0.7329
53A	**9**	4	13	2	15	3	18	4	**22**	1.823	0.6733
54A	**6**	7	13	12	25	2	27	5	**32**	2.416	0.7507
55A	**6**	3	9	4	13	6	19	4	**23**	1.897	0.7394
55B	**8**	5	13	3	16	6	22	5	**27**	1.825	0.6581
56A	**7**	9	16	12	28	6	34	8	**42**	2.199	0.6598
57A	**11**	9	20	3	23	4	27	5	**32**	2.629	0.8383
57B	**11**	5	16	6	22	5	27	5	**32**	2.169	0.7018
58A	**15**	12	27	8	35	6	41	5	**46**	2.860	0.8043
59A	**15**	13	28	5	33	4	37	11	**48**	2.655	0.7593
59B	**18**	15	33	9	42	4	46	13	**59**	3.109	0.8317
60A	**9**	8	17	9	26	6	32	10	**42**	2.553	0.7836
60B	**11**	4	15	10	25	5	30	8	**38**	2.359	0.7327
61A	**14**	11	25	6	31	3	34	9	**43**	2.574	0.7496
62A	**10**	7	17	17	34	7	41	10	**51**	2.250	0.6379
62B	**14**	17	31	17	48	4	52	14	**66**	3.070	0.7931
62C	**11**	12	23	16	39	3	42	9	**51**	2.780	0.7589
63A	**10**	3	13	9	22	5	27	4	**31**	2.169	0.7016
63B	**10**	1	11	7	18	3	21	3	**24**	1.887	0.6527
64A	**16**	11	27	6	33	8	41	12	**53**	2.679	0.7661
64B	**16**	17	33	8	41	8	49	8	**57**	2.754	0.7416
65A	**16**	11	27	4	31	6	37	10	**47**	2.611	0.7603
65B	**19**	9	28	4	32	5	37	8	**45**	2.865	0.8266
66A	**15**	8	23	8	31	8	39	14	**53**	2.718	0.7914
66B	**6**	7	13	11	24	6	30	11	**41**	1.927	0.6064
67A	**12**	14	26	12	38	4	42	11	**53**	2.758	0.7583
67B	**13**	5	18	11	29	2	31	12	**43**	2.029	0.6026
68A	**12**	14	26	4	30	1	31	13	**44**	2.715	0.7984
68B	**16**	8	24	6	30	2	32	13	**45**	2.817	0.8281
69A	**14**	11	25	21	46	9	55	12	**67**	2.817	0.7358
69B	**13**	14	27	18	45	8	53	17	**70**	3.045	0.7999
70A	**16**	12	28	12	40	6	46	20	**66**	3.066	0.8311
70B	**13**	6	19	14	33	7	40	17	**57**	2.753	0.7874
71A	**9**	21	30	14	44	4	48	18	**66**	2.601	0.6873
71B	**9**	11	20	12	32	6	38	15	**53**	2.266	0.6537
72A	**7**	9	16	11	27	3	30	13	**43**	2.102	0.6378
72B	**14**	12	26	7	33	4	37	8	**45**	3.091	0.8841
73A	**13**	13	26	12	38	3	41	7	**48**	2.750	0.7615
73B	**12**	15	27	10	37	2	39	10	**49**	2.700	0.7476
73C	**14**	12	26	10	36	1	37	8	**45**	2.786	0.7837
74A	**17**	17	34	11	45	5	50	21	**71**	2.967	0.7794
74B	**14**	11	25	16	41	4	45	19	**64**	2.941	0.7920
75A	**14**	14	28	19	47	7	54	15	**69**	2.946	0.7651

[1] Includes tree species not represented in tree layer.

[2] Includes tree and tall shrub species not represented in tree and tall shrub layers.

More than 70 species were recorded in plots 74A (Berlin Scrub) and 69B (Coominglah), and a majority of the plots (73) had totals of 40 or more species. On the other hand, only 5 plots contained fewer than 20 species, all in *Macropteranthes leichhardtii* stands in the Emerald-Springsure district. In a similar trend to the results for canopy trees (see above), plots in northern and inland areas contained markedly fewer species than those in south-eastern Queensland.

Shannon diversity indices ranged from 3.225 (plot 26B - Rundle Range) down to less than 1.0 in the Springsure district. Almost one-half of the plots (62/133) had indices of 2.5 or greater with only 4 plots (35A, 35B, 43A, 43B - near Emerald) having values of less than 1.4. Broad trends were similar to those for species richness.

Most plots (103) had evenness values of 0.70 or greater and only two (43A and 43B) were less than 0.50. Most of the 30 plots with evenness values of less than 0.70 were dominated by *Macropteranthes* spp. (*M. leichhardtii* and *M. leiocaulis*) and *Backhousia* spp. (*B. angustifolia* and *B. kingii*).

There were significant differences between the diversities of the classificatory groups within the vine thickets and these are discussed further below.

3.5.6 Species/area relationships and within-site variation

A major strength of the plotless approach to sampling is that sample dimensions are adjusted according to the density of the vegetation, which in the case of vine thickets is highly variable (see **Table 3.15**). In quadrat-based surveys, the adequacy of a sample is determined from species counts within a series of plots of increasing size. It has been possible in the present study, by noting the additional species recorded in each of the 4 subplots ("quarters") (see **Figure 3.4**), to draw up species/area relationships for 50 plots (**Table 3.16**).

Mean cumulative counts of tree and shrub species (as % of plot totals) for subplots 1, 1+2, and 1+2+3 were 64.6, 81.3 and 92.6% respectively. The corresponding mean cumulative areas were 26.9, 49.6 and 75.1% respectively. The species/area relationships for several replicate plots are illustrated in **Figure 3.8**

Table 3.16 Cumulative area and species totals (%) within 50 vine thicket plots.

PLOT		TOTAL	1	1+2	1+2+3	1+2+3+4
01A	Area (m^2)	310.07	29.6%	50.1%	85.4%	100.0%
	Species	43	51.2%	76.7%	95.3%	100.0%
21A	Area (m^2)	283.21	27.7%	50.2%	87.5%	100.0%
	Species	30	66.7%	83.3%	93.3%	100.0%
22A	Area (m^2)	347.23	26.9%	48.2%	74.6%	100.0%
	Species	38	68.4%	76.3%	92.1%	100.0%
22B	Area (m^2)	485.05	37.9%	58.2%	75.1%	100.0%
	Species	41	75.6%	87.8%	92.7%	100.0%
23A	Area (m^2)	370.73	18.3%	45.9%	72.9%	100.0%
	Species	27	55.6%	77.8%	88.9%	100.0%
24A	Area (m^2)	420.67	20.6%	57.2%	79.8%	100.0%
	Species	31	61.3%	83.9%	93.5%	100.0%
25A	Area (m^2)	398.04	16.3%	49.2%	79.1%	100.0%
	Species	30	56.7%	83.3%	96.7%	100.0%
28A	Area (m^2)	771.69	24.5%	37.5%	54.7%	100.0%
	Species	30	63.3%	86.7%	86.7%	100.0%
28B	Area (m^2)	439.54	14.8%	30.6%	76.4%	100.0%
	Species	27	55.6%	66.7%	88.9%	100.0%
30A	Area (m^2)	586.11	15.6%	50.0%	59.4%	100.0%
	Species	17	58.8%	82.4%	88.2%	100.0%
30B	Area (m^2)	567.56	32.0%	53.6%	71.3%	100.0%
	Species	24	45.8%	70.8%	83.3%	100.0%
31A	Area (m^2)	825.39	19.5%	41.5%	60.4%	100.0%
	Species	33	63.6%	87.9%	97.0%	100.0%
32A	Area (m^2)	473.48	29.8%	64.2%	79.2%	100.0%
	Species	13	61.5%	76.9%	84.6%	100.0%
33A	Area (m^2)	476.74	24.1%	47.9%	82.5%	100.0%
	Species	34	52.9%	82.4%	91.2%	100.0%
34A	Area (m^2)	415.96	63.3%	69.8%	87.6%	100.0%
	Species	18	77.8%	88.9%	100.0%	100.0%
34B	Area (m^2)	636.14	25.3%	55.3%	84.2%	100.0%
	Species	25	80.0%	92.0%	100.0%	100.0%
35A	Area (m^2)	563.52	21.4%	43.2%	66.1%	100.0%
	Species	6	66.7%	66.7%	83.3%	100.0%
36A	Area (m^2)	554.28	26.2%	59.8%	69.4%	100.0%
	Species	28	82.1%	85.7%	96.4%	100.0%
37A	Area (m^2)	423.79	36.3%	61.3%	82.9%	100.0%
	Species	31	58.1%	83.9%	96.8%	100.0%
38A	Area (m^2)	485.22	15.2%	34.1%	55.9%	100.0%
	Species	16	50.0%	68.8%	81.3%	100.0%
39A	Area (m^2)	649.6	25.8%	49.8%	74.2%	100.0%
	Species	27	70.4%	77.8%	85.2%	100.0%
40A	Area (m^2)	422.67	20.5%	50.5%	81.4%	100.0%
	Species	22	86.4%	90.9%	95.5%	100.0%
41A	Area (m^2)	511.94	28.0%	46.9%	74.9%	100.0%
	Species	22	54.5%	77.3%	95.5%	100.0%
43A	Area (m^2)	450.35	28.6%	60.9%	72.3%	100.0%
	Species	3	100.0%	100.0%	100.0%	100.0%
44A	Area (m^2)	547.71	16.7%	34.1%	69.0%	100.0%
	Species	20	85.0%	100.0%	100.0%	100.0%
45A	Area (m^2)	293.46	25.2%	53.6%	74.8%	100.0%
	Species	25	64.0%	84.0%	92.0%	100.0%

Table 3.16 (cont.)

PLOT		TOTAL	1	1+2	1+2+3	1+2+3+4
46A	Area (m^2)	506.72	34.4%	55.7%	79.5%	100.0%
	Species	28	82.1%	85.7%	92.9%	100.0%
48A	Area (m^2)	723.53	27.8%	67.0%	85.6%	100.0%
	Species	16	50.0%	62.5%	100.0%	100.0%
49A	Area (m^2)	381.81	30.6%	53.3%	76.4%	100.0%
	Species	27	55.6%	77.8%	88.9%	100.0%
49B	Area (m^2)	404.78	14.7%	45.0%	72.0%	100.0%
	Species	30	56.7%	83.3%	96.7%	100.0%
50A	Area (m^2)	436.47	27.2%	40.2%	78.6%	100.0%
	Species	20	75.0%	80.0%	95.0%	100.0%
51A	Area (m^2)	556.09	11.4%	39.1%	56.2%	100.0%
	Species	19	63.2%	78.9%	84.2%	100.0%
52A	Area (m^2)	291.95	16.8%	52.4%	83.2%	100.0%
	Species	25	28.0%	76.0%	92.0%	100.0%
53A	Area (m^2)	943	35.4%	58.3%	77.3%	100.0%
	Species	15	60.0%	93.3%	93.3%	100.0%
55A	Area (m^2)	598.3	16.8%	47.1%	67.6%	100.0%
	Species	13	46.2%	92.3%	92.3%	100.0%
55B	Area (m^2)	565.69	16.8%	46.4%	84.7%	100.0%
	Species	16	50.0%	81.3%	93.8%	100.0%
56A	Area (m^2)	367.29	23.6%	51.4%	77.7%	100.0%
	Species	28	60.7%	82.1%	92.9%	100.0%
57A	Area (m^2)	420.55	14.8%	28.3%	62.9%	100.0%
	Species	23	65.2%	87.0%	91.3%	100.0%
57B	Area (m^2)	394.44	25.0%	44.5%	73.2%	100.0%
	Species	22	54.5%	86.4%	100.0%	100.0%
59A	Area (m^2)	324.35	36.1%	50.2%	79.5%	100.0%
	Species	33	60.6%	75.8%	90.9%	100.0%
60A	Area (m^2)	400.54	34.7%	49.2%	85.5%	100.0%
	Species	26	73.1%	76.9%	96.2%	100.0%
60B	Area (m^2)	378.7	19.5%	46.5%	80.5%	100.0%
	Species	25	80.0%	88.0%	96.0%	100.0%
62A	Area (m^2)	442.1	23.9%	47.4%	76.1%	100.0%
	Species	34	61.8%	73.5%	91.2%	100.0%
62B	Area (m^2)	300.91	29.9%	60.4%	73.9%	100.0%
	Species	48	72.9%	87.5%	95.8%	100.0%
62C	Area (m^2)	235.89	28.2%	63.5%	85.9%	100.0%
	Species	39	51.3%	84.6%	97.4%	100.0%
63A	Area (m^2)	706.88	27.0%	54.8%	73.3%	100.0%
	Species	22	72.7%	81.8%	100.0%	100.0%
66B	Area (m^2)	372.15	23.3%	47.9%	72.1%	100.0%
	Species	24	58.3%	70.8%	91.7%	100.0%
67A	Area (m^2)	352.84	22.7%	46.8%	77.3%	100.0%
	Species	38	47.4%	73.7%	86.8%	100.0%
68A	Area (m^2)	429.76	19.0%	39.6%	75.4%	100.0%
	Species	30	53.3%	76.7%	90.0%	100.0%
75A	Area (m^2)	326.21	17.0%	40.6%	71.9%	100.0%
	Species	47	40.4%	70.2%	83.0%	100.0%

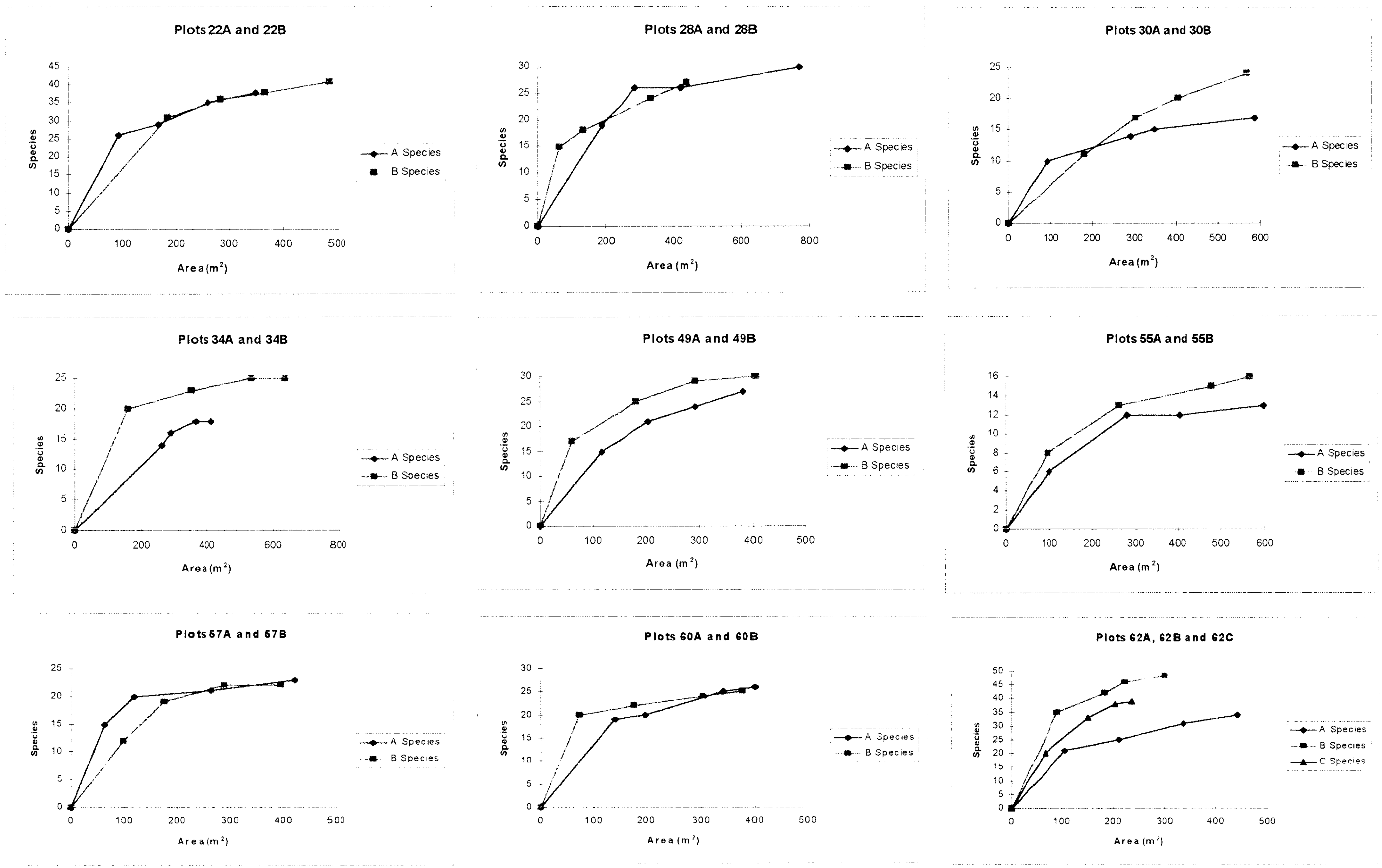


Figure 3.8. Species/area relationships for replicate plts from 9 sites (22, 28, 30, 34, 49, 55, 57, 60 and 62), representing a range of vine thicket community-types.

Even where species/area data were lacking, it was possible to compare species counts for duplicate plots, the number of species in common and the proportion of the site area and species total sampled by each plot at 55 of the 75 sites (see **Table 3.17**).

For 86 of the 110 plots, the counts of tree and shrub species reached 75% or more of the respective site totals, and only two plots (23A and 43A) had less than 60%. Marked differences between some replicate plots may be explained by their relative sizes (e.g. sites 23, 28, 30, 34, 66 and 72), but at other sites, the smaller plots have the larger species totals (e.g. 6, 8, 45, 46, 47, 55 and 67).

The proportion of tree and shrub species shared by replicate plots was greater than 50% of the total for most sites (48/55), and in only two sites (23 and 63 - Dan Dan and "Stuart Downs") was the proportion less than 40%. For these latter sites, the proportion was marginally increased by the addition of vine species to the data set, but in the majority of sites (38/55), this led to a decrease in the proportion of shared species.

Table 3.17 Species counts for replicate plots - species in common and comparisons with totals for 55 vine thicket sites.

	Tree and shrub species							Tree, shrub and vine species							Areas		
Site	Spp.	A	B	A/B*	Ppn A	Ppn B	Ppn A/B	Spp.	A	B	A/B	Ppn A	Ppn B	Ppn A/B	A + B	Ppn A	Ppn B
2	34	33	26	25	0.97	0.76	0.74	47	42	37	32	0.89	0.79	0.68	1077.5	0.43	0.57
3	23	19	21	17	0.83	0.91	0.74	31	25	26	20	0.81	0.84	0.65	1026.6	0.48	0.52
4	27	25	24	22	0.93	0.89	0.81	34	29	30	25	0.85	0.88	0.74	858.8	0.51	0.49
6	37	30	26	19	0.81	0.70	0.51	51	39	38	26	0.76	0.75	0.51	699.8	0.44	0.56
7	22	20	14	12	0.91	0.64	0.55	29	26	18	15	0.90	0.62	0.52	1039.5	0.51	0.49
8	21	16	18	13	0.76	0.86	0.62	27	21	21	15	0.78	0.78	0.56	926.8	0.60	0.40
10	21	18	19	16	0.86	0.90	0.76	27	24	25	22	0.89	0.93	0.81	1212.1	0.50	0.50
11	15	13	12	10	0.87	0.80	0.67	23	21	17	15	0.91	0.74	0.65	860.1	0.58	0.42
12	18	16	17	15	0.89	0.94	0.83	26	22	23	19	0.85	0.88	0.73	822.2	0.43	0.57
13	22	18	18	14	0.82	0.82	0.64	28	22	22	16	0.79	0.79	0.57	1249.7	0.49	0.51
14	24	18	22	16	0.75	0.92	0.67	31	23	28	20	0.74	0.90	0.65	857.2	0.51	0.49
15	34	29	31	26	0.85	0.91	0.76	48	42	42	36	0.88	0.88	0.75	719.3	0.49	0.51
16	33	28	24	19	0.85	0.73	0.58	46	40	32	26	0.87	0.70	0.57	926.7	0.48	0.52
17	30	23	26	19	0.77	0.87	0.63	43	33	36	26	0.77	0.84	0.60	967.1	0.49	0.51
20	42	36	28	22	0.86	0.67	0.52	60	49	40	29	0.82	0.67	0.48	1255.7	0.47	0.53
21	39	30	33	24	0.77	0.85	0.62	56	41	47	32	0.73	0.84	0.57	711.8	0.40	0.60
22	47	38	41	32	0.81	0.87	0.68	66	55	58	47	0.83	0.88	0.71	832.2	0.42	0.58
23	48	27	37	16	0.56	0.77	0.33	67	41	51	25	0.61	0.76	0.37	967.8	0.38	0.62
26	50	39	42	31	0.78	0.84	0.62	63	50	50	37	0.79	0.79	0.59	1225.0	0.53	0.47
27	42	36	34	28	0.86	0.81	0.67	58	50	44	36	0.86	0.76	0.62	942.4	0.52	0.48
28	38	30	27	19	0.79	0.71	0.50	56	46	40	30	0.82	0.71	0.54	1100.0	0.70	0.30
30	28	17	24	13	0.61	0.86	0.46	41	25	36	20	0.61	0.88	0.49	1447.0	0.41	0.59

* i.e. species common to A and B.

Table 3.17 (cont.)

	Tree and shrub species							Tree, shrub and vine species							Areas		
Site	Spp.	A	B	A/B*	Ppn A	Ppn B	Ppn A/B	Spp.	A	B	A/B	Ppn A	Ppn B	Ppn A/B	A + B	Ppn A	Ppn B
34	27	18	25	16	0.67	0.93	0.59	34	23	30	19	0.68	0.88	0.56	1052.1	0.40	0.60
35	8	6	7	5	0.75	0.88	0.63	11	8	9	6	0.73	0.82	0.55	1022.3	0.55	0.45
36	32	28	25	21	0.88	0.78	0.66	44	38	32	26	0.86	0.73	0.59	1013.1	0.55	0.45
37	33	31	22	20	0.94	0.67	0.61	44	41	24	21	0.93	0.55	0.48	851.5	0.50	0.50
38	18	16	16	14	0.89	0.89	0.78	27	23	23	19	0.85	0.85	0.70	887.2	0.55	0.45
39	31	27	24	20	0.87	0.77	0.65	40	35	29	24	0.88	0.73	0.60	1133.5	0.57	0.43
40	24	22	18	16	0.92	0.75	0.67	34	32	26	24	0.94	0.76	0.71	899.1	0.47	0.53
41	26	22	19	15	0.85	0.73	0.58	37	32	28	23	0.86	0.76	0.62	1082.4	0.47	0.53
43	6	3	6	3	0.50	1.00	0.50	9	5	9	5	0.56	1.00	0.56	785.0	0.57	0.43
44	27	20	25	18	0.74	0.93	0.67	34	25	29	20	0.74	0.85	0.59	1189.4	0.46	0.54
45	32	25	23	16	0.78	0.72	0.50	41	32	29	20	0.78	0.71	0.49	693.3	0.42	0.58
46	31	28	23	20	0.90	0.74	0.65	45	40	33	28	0.89	0.73	0.62	1374.3	0.37	0.63
47	32	25	25	18	0.78	0.78	0.56	44	36	30	22	0.82	0.68	0.50	1403.1	0.65	0.35
48	20	16	15	11	0.80	0.75	0.55	26	21	20	15	0.81	0.77	0.58	1351.2	0.54	0.46
49	35	27	30	22	0.77	0.86	0.63	46	34	39	27	0.74	0.85	0.59	786.6	0.49	0.51
50	27	20	21	14	0.74	0.78	0.52	34	27	26	19	0.79	0.76	0.56	864.8	0.50	0.50
51	27	19	21	13	0.70	0.78	**0.48**	30	22	23	15	0.73	0.77	0.50	1063.6	0.52	0.48
52	31	25	27	21	0.81	0.87	0.68	39	30	34	25	0.77	0.87	0.64	927.9	0.31	0.69
55	17	13	16	12	0.76	0.94	0.71	24	17	21	14	0.71	0.88	0.58	965.6	0.62	0.38
57	29	23	22	16	0.79	0.76	0.55	38	30	27	19	0.79	0.71	0.50	862.7	0.49	0.51
59	51	33	42	24	0.65	0.82	**0.47**	70	44	57	31	0.63	0.81	0.44	645.3	0.50	0.50
60	29	26	25	22	0.90	0.86	0.76	40	35	33	28	0.88	0.83	0.70	724.4	0.55	0.45
63	29	22	18	11	0.76	0.62	**0.38**	34	26	22	14	0.76	0.65	0.41	1361.2	0.52	0.48
64	50	33	41	24	0.66	0.82	**0.48**	65	46	49	30	0.71	0.75	0.46	644.6	0.54	0.46
65	40	31	32	23	0.78	0.80	0.58	53	41	40	28	0.77	0.75	0.53	748.9	0.54	0.46
66	36	31	24	19	0.86	0.67	0.53	50	45	35	30	0.90	0.70	0.60	924.2	0.60	0.40
67	44	38	29	23	0.86	0.66	0.52	60	49	41	30	0.82	0.68	0.50	880.3	0.40	0.60
68	40	30	30	20	0.75	0.75	0.50	56	43	43	30	0.77	0.77	0.54	840.6	0.51	0.49
69	56	46	45	35	0.82	0.80	0.63	77	58	62	43	0.75	0.81	0.56	691.8	0.51	0.49
70	47	40	33	26	0.85	0.70	0.55	72	60	50	38	0.83	0.69	0.53	862.8	0.48	0.52
71	48	44	32	28	0.92	0.67	0.58	68	62	47	41	0.91	0.69	0.60	976.7	0.54	0.46
72	41	27	33	19	0.66	0.80	**0.46**	57	40	42	25	0.70	0.74	0.44	742.5	0.35	0.65
74	54	45	41	32	0.83	0.76	0.59	79	66	60	47	0.84	0.76	0.59	789.7	0.52	0.48

* i.e. species common to A and B.

3.6 Results of numerical analyses

3.6.1 Plot classifications

Comparisons of the results of classifications of relative importance and cover class data and of species presence/absence data (**Analyses 1-13** - see **Table 3.18**) were made at the 7- and 8-group levels, as the (default) 12-group classifications produced numerous mismatches between site pairs.

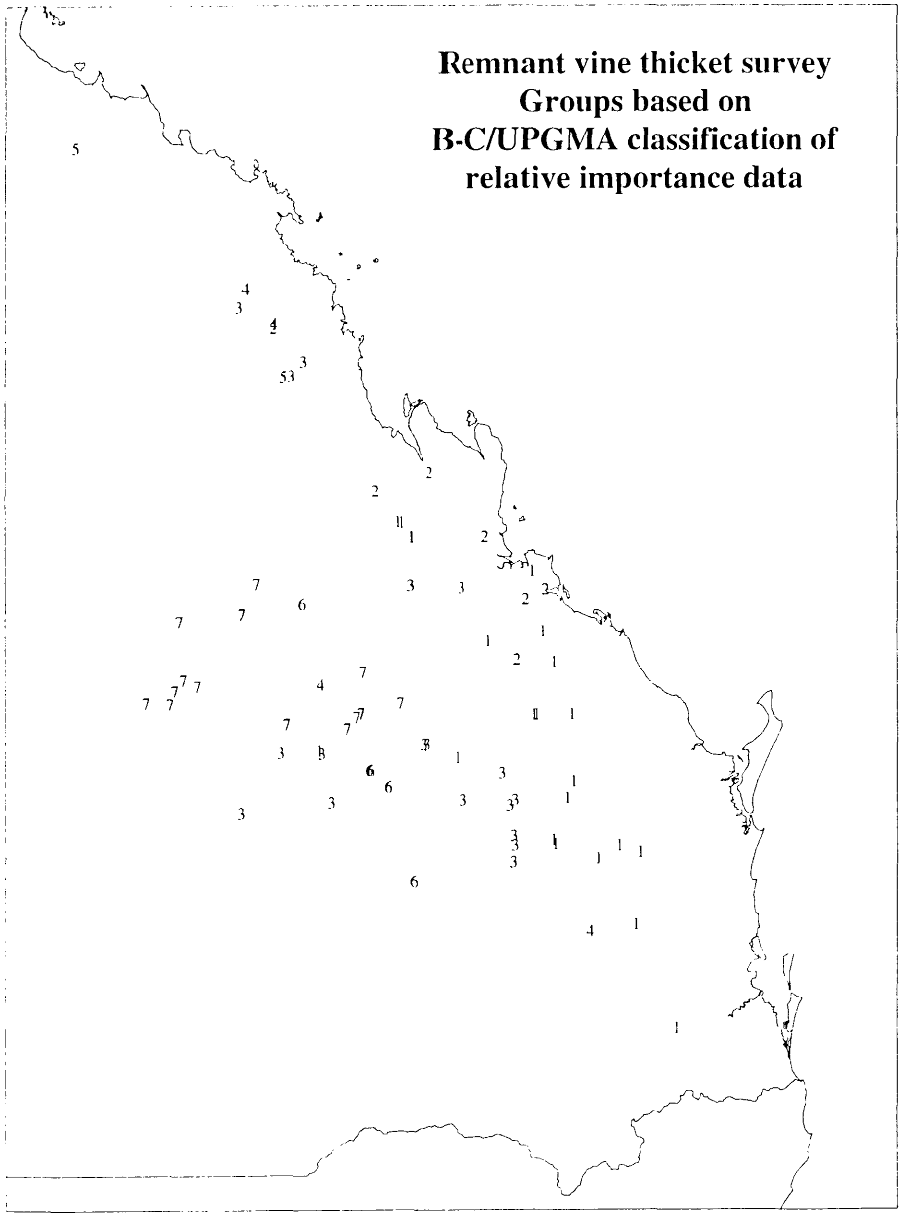
Table 3.18 List of classifications carried out on vine thicket plot data

An.	Classification	Attributes	Plots	Spp.
1	B-C/UPGMA	Relative importance data	142	131
2	B-C/UPGMA	Rel_imp. data, minus bottle trees	142	128
3	B-C/UPGMA	Rel_imp. data, "cover" plots only	133	127
4	B-C/UPGMA	Rel_imp. data, "cover" plots only, minus bottle trees	133	123
5	B-C/UPGMA	Cover data, standardised, canopy species only	133	134
6	B-C/UPGMA	Cover data, stand., canopy species only, minus single species records	133	109
7	B-C/UPGMA	Cover data, stand., all tree & shrub species	133	187
8	B-C/UPGMA	Cover data, stand., all tree & shrub species, minus single species recs.	133	150
9	B-C/UPGMA	Trees, shrubs, presence/absence data	136	191
10	B-C/UPGMA	Trees, shrubs, p/a data, minus single species	136	157
11	B-C/UPGMA	T/s, vines, presence/absence	136	256
12	B-C/UPGMA	T/s, vines, p/a data, minus single species	136	216
13	TWINSPAN	Trees, shrubs and vines, presence/absence, minus single species.	136	216

Distribution maps of the vine thicket site-groups derived from classifications (**Figures 3.9, 3.10**) of both abundance and presence/absence data show broadly similar geographical trends, with 3-4 subcoastal groups and 3-4 inland groups. Of the subcoastal groups there is one based on south-eastern Queensland (Burnett and Moreton districts) and another based on the northern Brigalow Belt region (Nebo/Collinsville district). The central region (Port Curtis district) vine thickets form a separate group in some analyses (e.g. **An 7, An 9**) and in others are split between the northern and south-eastern groups (e.g. **An 5**).

The inland vine thicket sites are divided into broadly north-western and south-eastern groups. The north-western group generally comprises the bonewood (*Macropteranthes leichhardtii*) - dominated vine thickets. Certain sites with ooline (*Cadellia pentastylis*) may also form a separate group (e.g. **An 5**). These distinctions were not made in the analyses based on presence/absence data, but the latter consistently recognised an additional group based on the western Burnett (Auburn) district, which overlaps to a varying extent, depending on the analysis, with the south-eastern group noted above.

Most analyses produced at least one group comprising a single site or locality. Of particular note was site 48 (Mingela Bluff), the northern-most site in the study area. Analyses based on abundance (relative importance) of canopy species placed it with the Dipperu (a) plot (32A), which is also dominated by *Macropteranthes leiocaulis*. When the associated species were considered, it was placed alone because of several northern elements (e.g. *Croton arnhemicus, Antidesma parvifolium*), while the Dipperu site was placed with the Central Highlands bonewood communities.



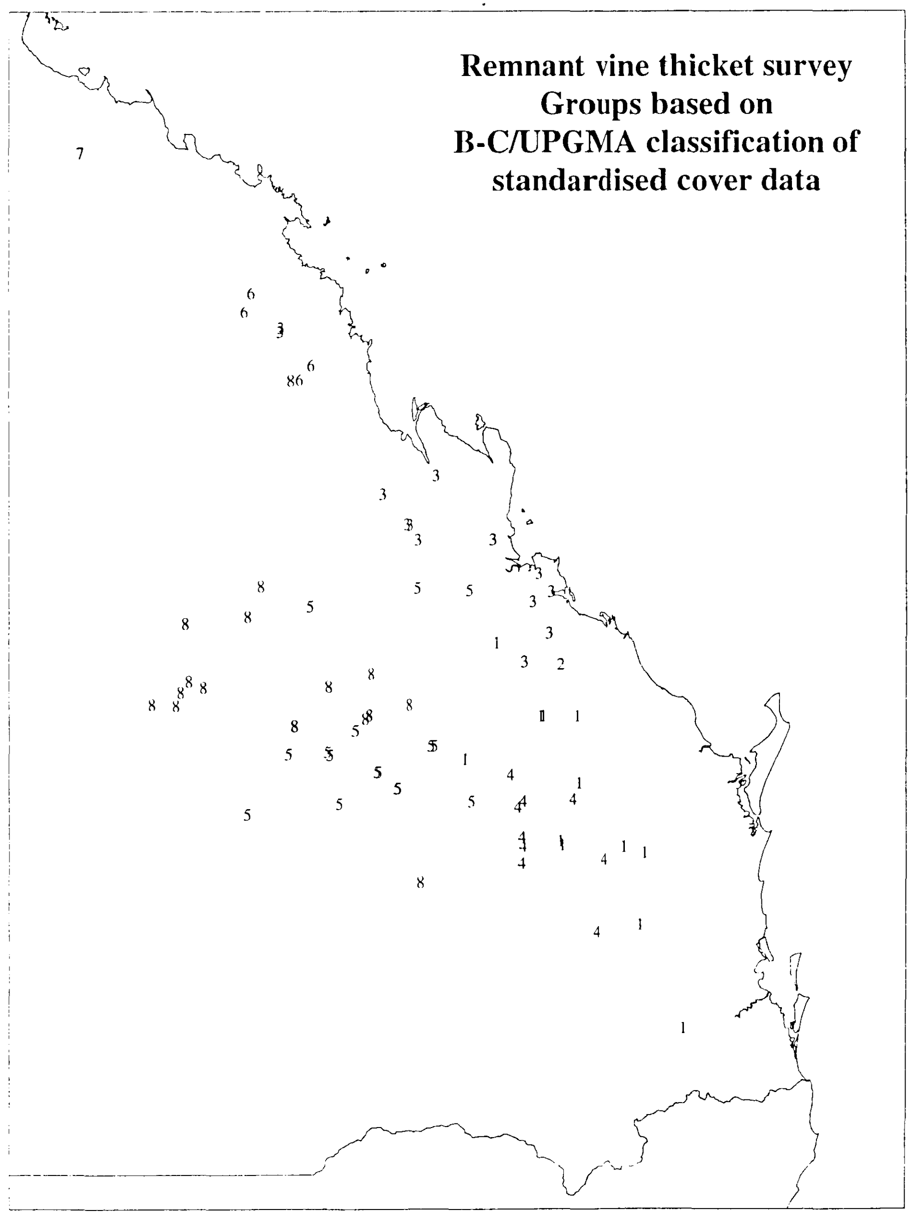
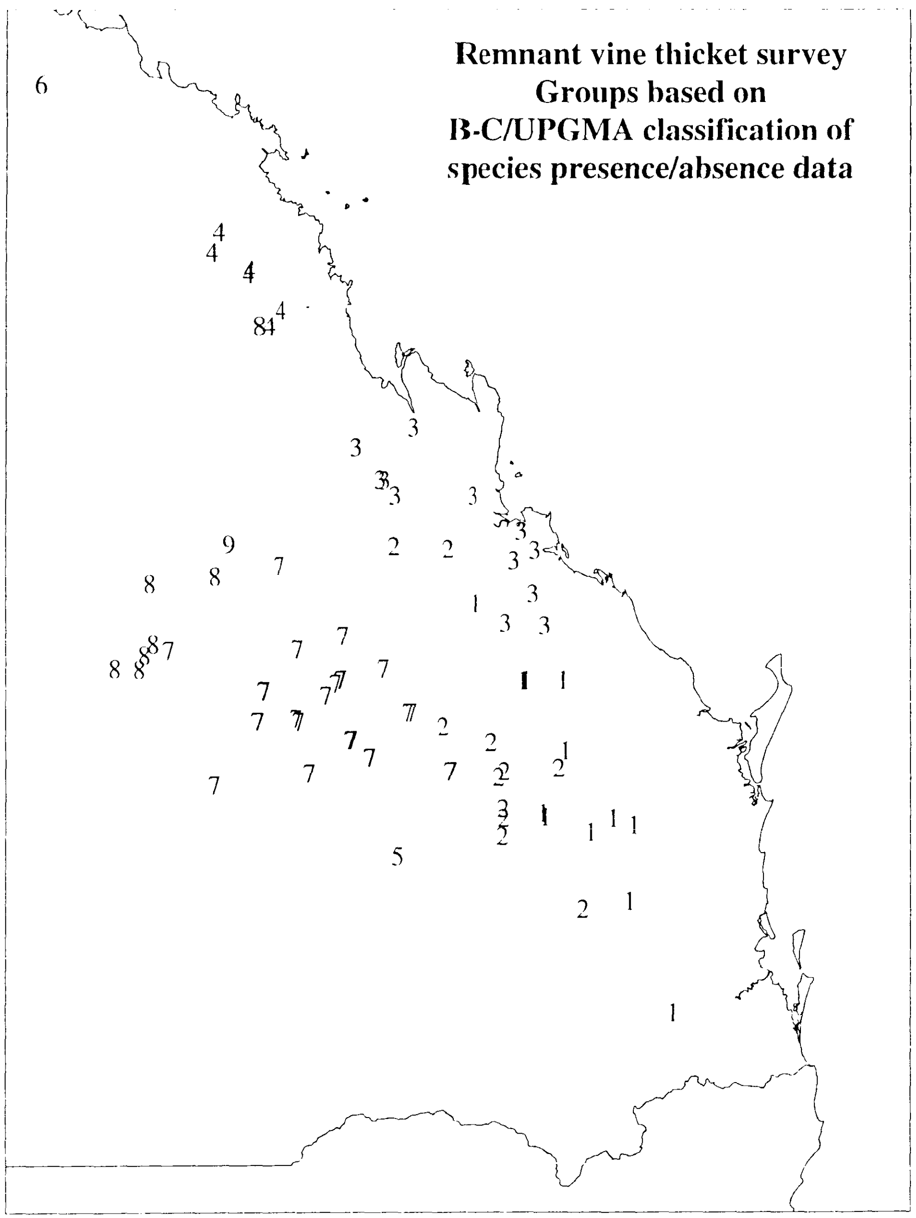


Figure 3.9. Distribution of vine thicket site groups in central and southern Queensland, based on classification of species abundance data.



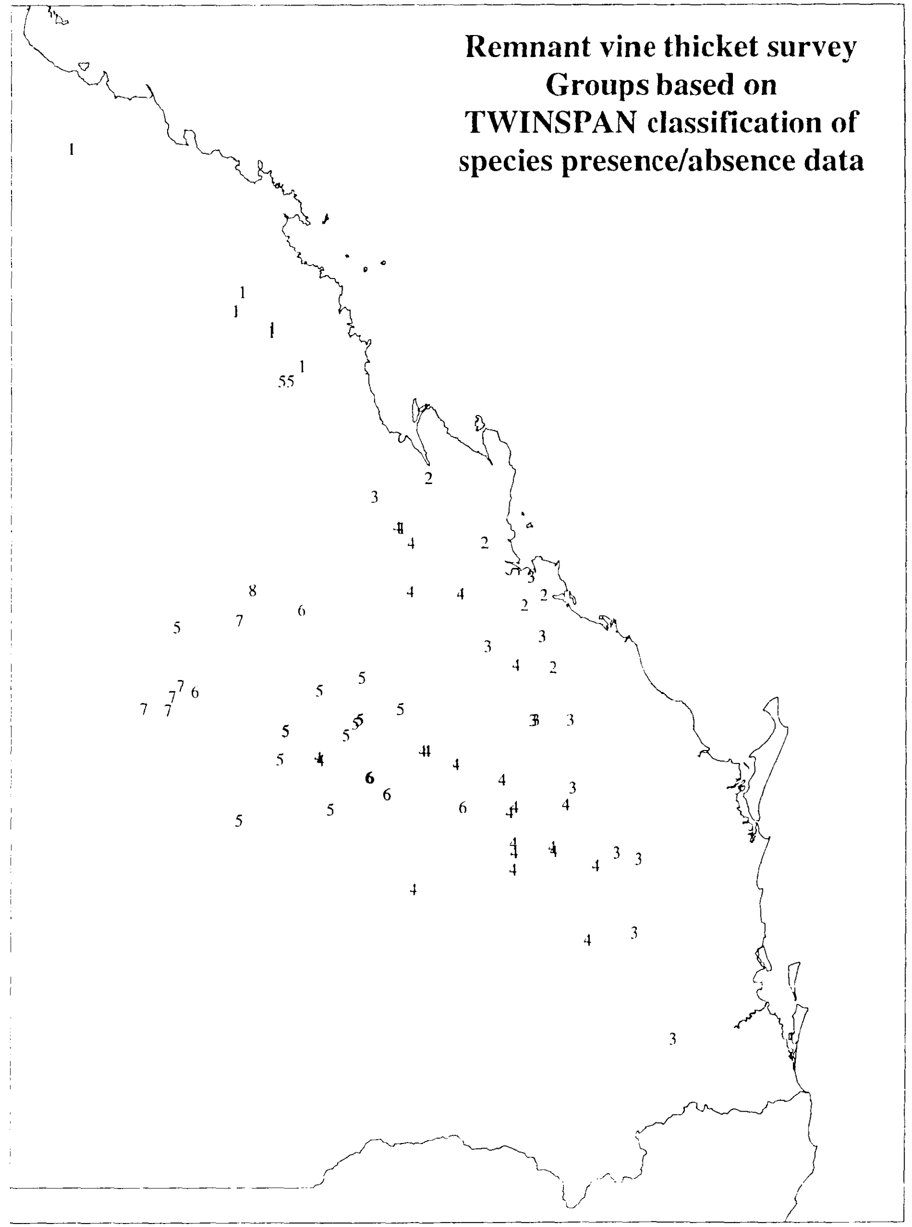


Figure 3.10. Distribution of vine thicket site groups in central and southern Queensland, based on classification of species presesnce/absence data.

Site 22 (Koolkoorum, south of Gladstone) contained several disjunct species (*Fontainea venosa, Atalaya calcicola* and *Backhousia citriodora*) which although locally common here, were recorded from no other sites during the survey. Analyses based on canopy cover separated this site from the other Port Curtis vine thickets.

3.6.1.1 Agglomerative procedure (Bray-Curtis/UPGMA) using quantitative data

3.6.1.1.1 Relative importance (analyses 1-4)

These data produced the least satisfactory classification in terms of consistency between site-pairs. At the 12-group level, replicate plots from 22 sites were mismatched (**An 1**). At the 8-group level, 5 mismatches were removed (sites 3, 36, 47, 68 and 72), with a further mismatch (site 27) removed by restricting the classification to 7 groups. Even at this level, 18 mismatches remained, representing almost one-quarter of the sites.

Much of the variation in basal area and therefore relative importance values is associated with presence or absence of large bottle trees (*Brachychiton* spp.). A second classification (**An 2**) used a data set from which the bottle trees (*Brachychiton australis, B. discolor* and *B. rupestris*) had been removed and relative importance values re-calculated for all other species. *Brachychiton* spp. occur in, or at least in close proximity to, 66 of the 75 sites in this study. They are also known to occur in the broader surrounds of 8 of the remaining sites and appear to be absent only from site 21 (Yarrol Scrub). Removal of data for these taxa therefore is unlikely to affect between-site distinctions significantly, while removing a major source of within-site (between-replicate) variation.

The results showed a considerable improvement, with 10 of the initial mismatches removed at the 12-group level, although two have been added (sites 36 and 68). Agreement between site-pairs was even further improved at the 7-group level, with only 7 mismatches remaining (sites 3, 4, 18, 29, 62, 66 and 72).

To allow comparisons with the results of the classifications based on cover class and species presence/absence data, further analyses (**An 3, 4**) were carried out on data from 133 plots, excluding plots 1B, 1C, 18B, 19B, 24B, 25B, 29B, 33B and 36B from the original data set. This removed only four of the initial 131 species - *Eucalyptus dolichocarpa, Ficus virens* var. *sublanceolata, Pavetta* *australiensis* and *Planchonella pohlmaniana* - each of which was recorded only once and would have had little influence on the classifications.

This classification produced 19 mismatches at the 12-group level (15 at the 7-group level). The omission of plots 18B, 19B and 29B from the analysis removed 3 of the mismatched site-pairs from the original classification.

When *Brachychiton* spp. were excluded, the classification of the 133 plots at the 7-group level was identical to that obtained with the original 142-plot data set, including the 7 mismatches .

The major species in each site-group (i.e. with mean values for relative importance of 0.05 or greater) are shown in **Table 3.19**. Group 1, comprising 32 plots, has no clearly dominant species, but *Excoecaria dallachyana, Geijera paniculata* and *Planchonella cotinifolia* var. *pubescens* are all significant. The major species in group 2 (15 plots) are *Archidendropsis thozetiana, Backhousia kingii, Planchonella cotinifolia* var. *pubescens* and *Pleiogynium timorense*. *P. cotinifolia* var. *pubescens* is also important in group 3 (21 plots), together with *Notelaea microcarpa* and *Acacia fasciculifera*.

Table 3.19 Mean values for major species in vine thicket site-groups based on relative importance data (classifications An 2 and An 4 - *Brachychiton* spp. excluded).

	SITE-GROUP						
SPECIES	1	2	3	4	5	6	7
ACACFASC	0.026	0.010	**0.052**	0	**0.056**	0.022	0.026
ACACHARP	0	0	0.005	0	0.029	**0.081**	0.026
ARCHTHOZ	0.015	**0.110**	0.003	0.021	0	0	0.001
BACKANGU	0.005	0.009	0.033	**0.421**	0	0	0.004
BACKKING	0.010	**0.181**	0	0	0	0	0
CADEPENT	0	0	0.006	0	0	**0.508**	0.018
EXCODALL	**0.135**	0.041	0.017	0	0	0.028	0.011
GEIJPANI	**0.073**	0.010	0.003	0	0	0	0
GEIJPARV	0.001	0	0.049	0	0	**0.055**	**0.056**
LYSIHOOK	0.005	0.006	0.046	0.047	**0.065**	0	0.004
MACRLEIC	0	0	0	0.030	0	0.003	**0.585**
MACRLEIO	0.013	0.015	0	0	**0.745**	0	0
NOTEMICR	0.030	0.002	**0.074**	**0.126**	0	0.025	0.020
PLANCOPU	**0.079**	**0.126**	**0.208**	**0.119**	0.011	**0.073**	0.046
PLEITIMO	0.004	**0.056**	0	0.044	0	0	0

The remaining four groups all have one obviously dominant species. In group 4 (31 plots) it is *Backhousia angustifolia*, with *N. microcarpa* and *P. cotinifolia* var. *pubescens* also significant.

Groups 5 (9 plots), 6 (3 plots) and 7 (31 plots) are dominated by *Macropteranthes leiocaulis, Cadellia pentastylis* and *M. leichhardtii* respectively.

The distributions of the various groups are somewhat diffuse and there are considerable geographical overlaps, e.g. between group 1 (south-east Queensland) and group 2 (central Queensland) (see **Figure 3.9**).

3.6.1.1.2 Crown cover data (analyses 5-8)

Classification of cover data produced more satisfactory results than those achieved with relative importance values, both in terms of geographically-consistent groups and in agreement between site-pairs. When the data for the 134 (potential) canopy species were classified at the 12-group level, there were only 8 sites (13, 23, 62, 63, 64, 67, 70 and 72) where replicate plots were placed in different groups.

When data for 53 low tree and shrub species were added, mismatches occurred for only 4 sites, 39, 62, 63 and 64. Each was further improved (but only by 1 mismatch) by adopting a higher-level (8-group) classification.

The results of the four classifications (**An 5-8**) agreed quite closely at the 8-group level, with 101 plots (75.9%) being unaffected by the addition of understorey species to the data sets or the removal of "singleton" species (i.e. those recorded from a single plot).

On canopy species alone (**An 5**), a group of 11 central Queensland plots (23A, 26A , 26B, 29A, 67A, 71A, 71B, 73A, 73B and 73C) was placed with the south-eastern Queensland group. When data for low tree and shrub species were added (**An 7**), this group was placed with other central Queensland plots (also removing mismatches for sites 23 and 72).

Removal of "singleton" species from the data sets affected the classifications (at the 8-group level) of 17 plots, but there were no clear trends. For four plots (13A, 53A, 54A and 62A), classifications based on canopy species only and on trees and shrubs were both affected by deletion of "singletons", but for each of the other 13 plots only one classification was affected (7 and 6 plots for **An 6 and An 8** respectively). There was no overall decrease in within-site variation, and it appears that with quantitative data at least there is little justification for removing "singletons".

An 7 (all tree and shrub species) was chosen ultimately as the preferred vine thicket classification (see below) and descriptions of the site-groups with notes on species abundance and frequency are presented in section **3.7.1**.

3.6.1.2 Floristic classifications (presence/absence data)

3.6.1.2.1 Agglomerative procedure - Bray-Curtis/UPGMA (analyses 9-12)

Results showed a high level of agreement between analyses (**An 9-12**) with 113 of the 136 plots (i.e. 83%) in equivalent groups (at the 8- group level). Within-site agreement was much higher than with quantitative data - of the 58 site-pairs, only plots 23A and 23B were mismatched, and then only when "singleton" species were included in the classification (**An 9, 11**).

The exclusion of "singleton' species (**An 10,12**) also influenced the classification of three other groups of plots. Plots 23A, 26A and 26B (Dan Dan and Rundle Range), initially placed in the south-eastern Queensland site-group, were placed with other central Queensland plots when "singleton" species were removed from the data sets. Plots 42A and 56A (Telemon and Vandyke Creek) were placed with other Springsure district plots (rather than in the Nebo/Mackay site-group). Plots 60A, 60B, 61A (Allies Creek), 64A, 64B (Reinkes Scrub) and 65A and 65B (Peannga), forming a subset of the Auburn site-group) moved into the south-eastern Queensland site-group when the "singletons" were removed (the Peannga plots should remain in the Auburn site-group however).

The inclusion of vine species in the data sets also affected the placement of several plots, and generally improved the group definitions, especially when "singleton" species were removed (**An 12**). Plots 31A, 44A, 45A and 45B were transferred from the central Queensland site-group to the Nebo/Mackay group, while plots 11A, 11B and 32A were moved (with 42A and 56A) to the Central Highlands (Springsure) site-group.

This latter classification (i.e. **An 12**) is considered the most satisfactory of the floristic (i.e. species presence/absence) classifications. The resultant site-groups (see **Table 3.20 and Figure 3.10**) are broadly similar in distribution to those obtained with cover data (tree and shrub species - **An** 7) (see section **3.6.1.1.2**) but differ in several respects. The northern (Nebo) site-group is more clearly defined and includes plots 30A, 30B, 46A and 46B (Mt Britten area) which in the cover-based classification form an outlier of the central Queensland site-group. There is no clear distinction between the *Macropteranthes leichhardtii* - dominant sites and the more complex vine thicket stands in the Injune-Taroom district; however, it is possible to separate (in ordination space) the eastern *M. leichhardtii* sites (Palmgrove, Oombabeer, Brigalow RS) from the stands in the Springsure district (e.g. see **Figure 3.11**).

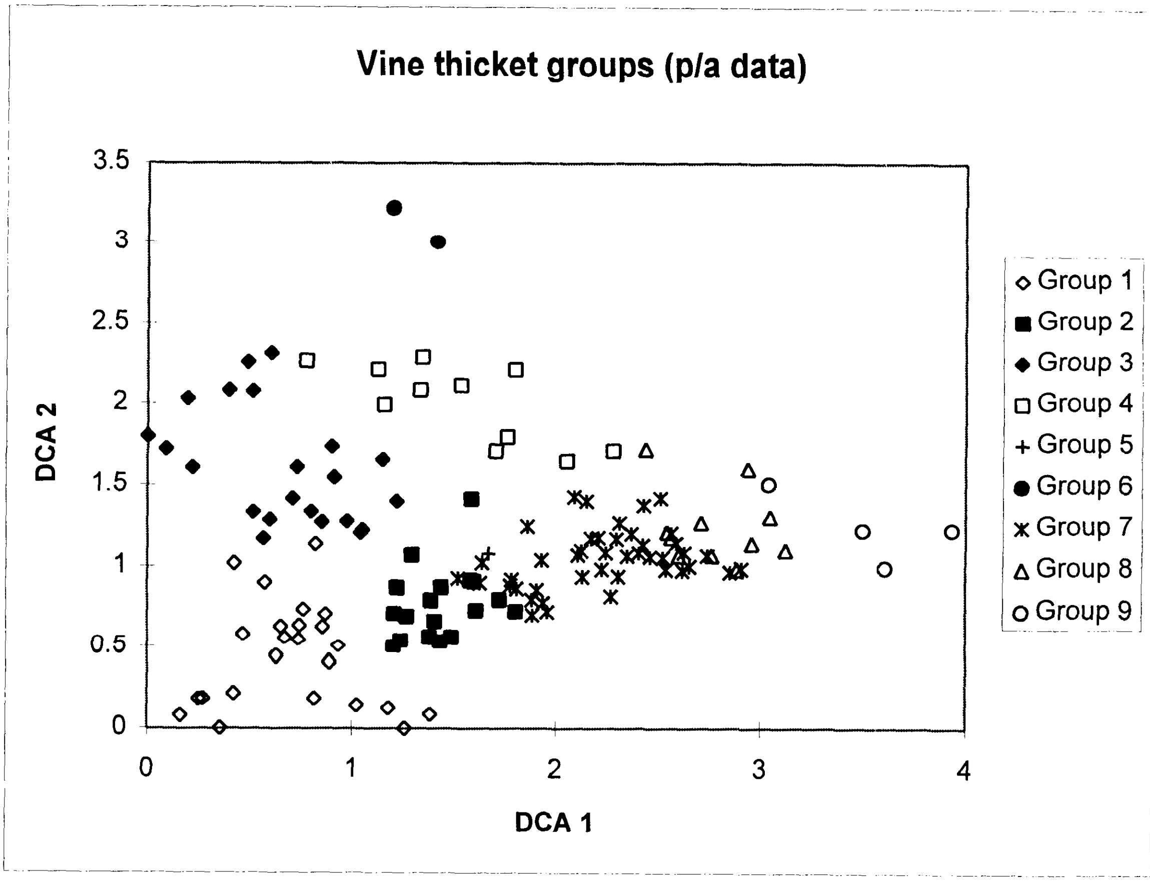
Table 3.20 List of plots in 9 site-groups based on classification (B-C/UPGMA) of species presence/absence data for 136 vine thicket plots (An 12).

Group	No. Plots	Plots												
1	24	01A	01B	01C	21A	21B	59A	59B	60A	60B	61A	62A	62B	62C
		64A	64B	68A	68B	69A	69B	70A	70B	74A	74B	75A		
2	18	02A	02B	03A	03B	04A	04B	05A	06A	06B	09A	19A	20A	20B
		33A	65A	65B	66A	66B								
3	22	22A	22B	23A	23B	24A	25A	26A	26B	27A	27B	28A	28B	29A
		67A	67B	71A	71B	72A	72B	73A	73B	73C				
4	11	30A	30B	31A	44A	44B	45A	45B	46A	46B	47A	47B		
5	1	53A												
6	2	48A	48B											
7	43	07A	07B	08A	08B	10A	10B	12A	12B	13A	13B	14A	14B	15A
		15B	16A	16B	17A	17B	18A	36A	36B	37A	37B	38A	38B	39A
		39B	40A	40B	49A									
8	11	11A	11B	32A	34A	34B	41A	41B	42A	54A	55A	55B		
9	4	35A	35B	43A	43B									

3.6.1.2.2 Divisive procedure - TWINSPAN (analysis 13)

When the results of the TWINSPAN classification were compared with those from the preferred agglomerative procedure (**An 12**) (see **3.6.1.2.2** above), there was considerable agreement, with 110 of the 136 plots (i.e. 80.9%) placed in equivalent groups by the two classifications. TWINSPAN however produced 6 site mismatches (sites 44, 64, 67, 68, 72 and 73).

Compared with **An 12**, the TWINSPAN results (**An 13**) showed far more overlap (in a geographical sense at least) between the South-eastern Queensland (**SEQ**), Central Queensland (**CQ**) and **Auburn** site-groups. The **Auburn** group was larger by 16 plots, gaining 5 from **SEQ** (60A, 60B, 61A, 64A and 68B), 4 from **CQ** (29A, 71A, 73A and 73B) and 7 from the **Taroom group** (15A, 15B, 16A, 16B, 49A, 49B and 58A). Five **CQ** plots (23A, 23B, 26A, 26B and 67A) were now placed in **SEQ** and 2 (71B and 72A) in the northern (**Nebo**) site-group.



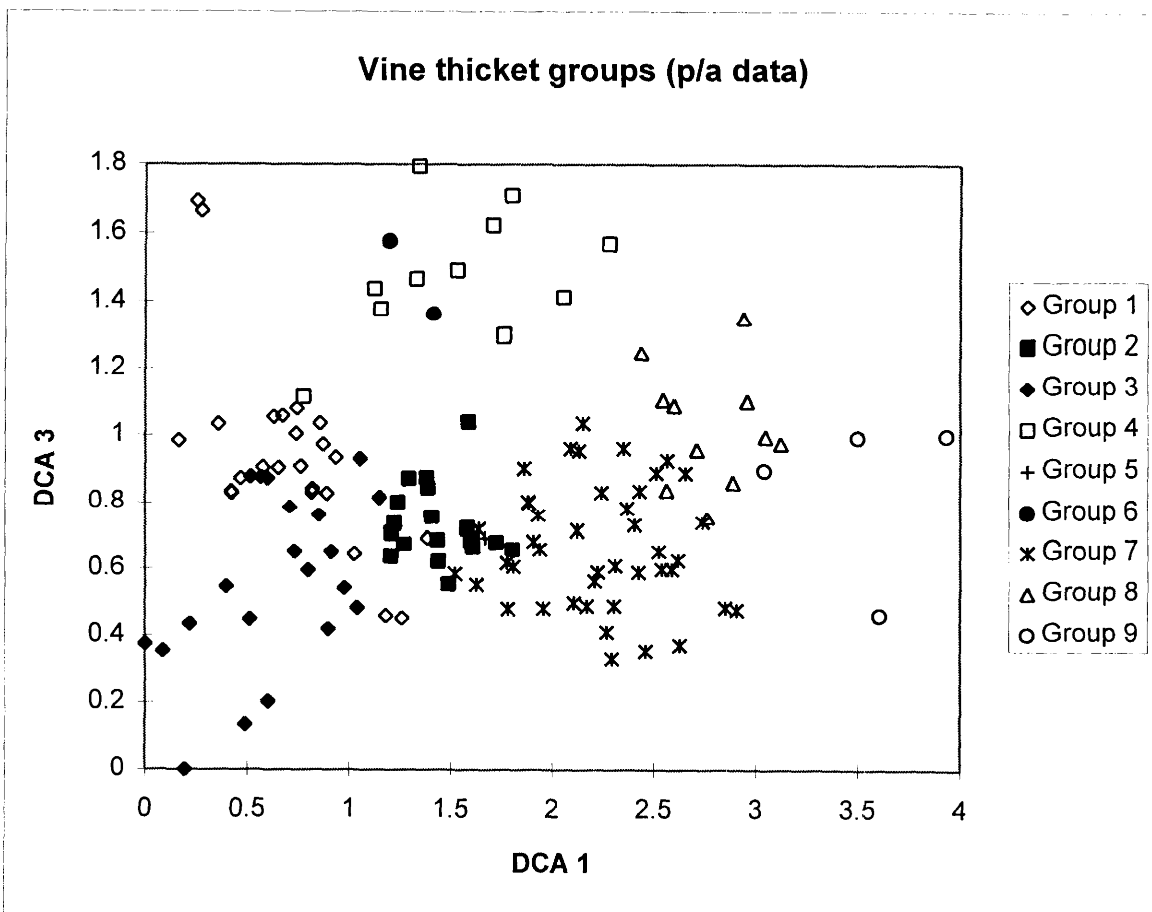
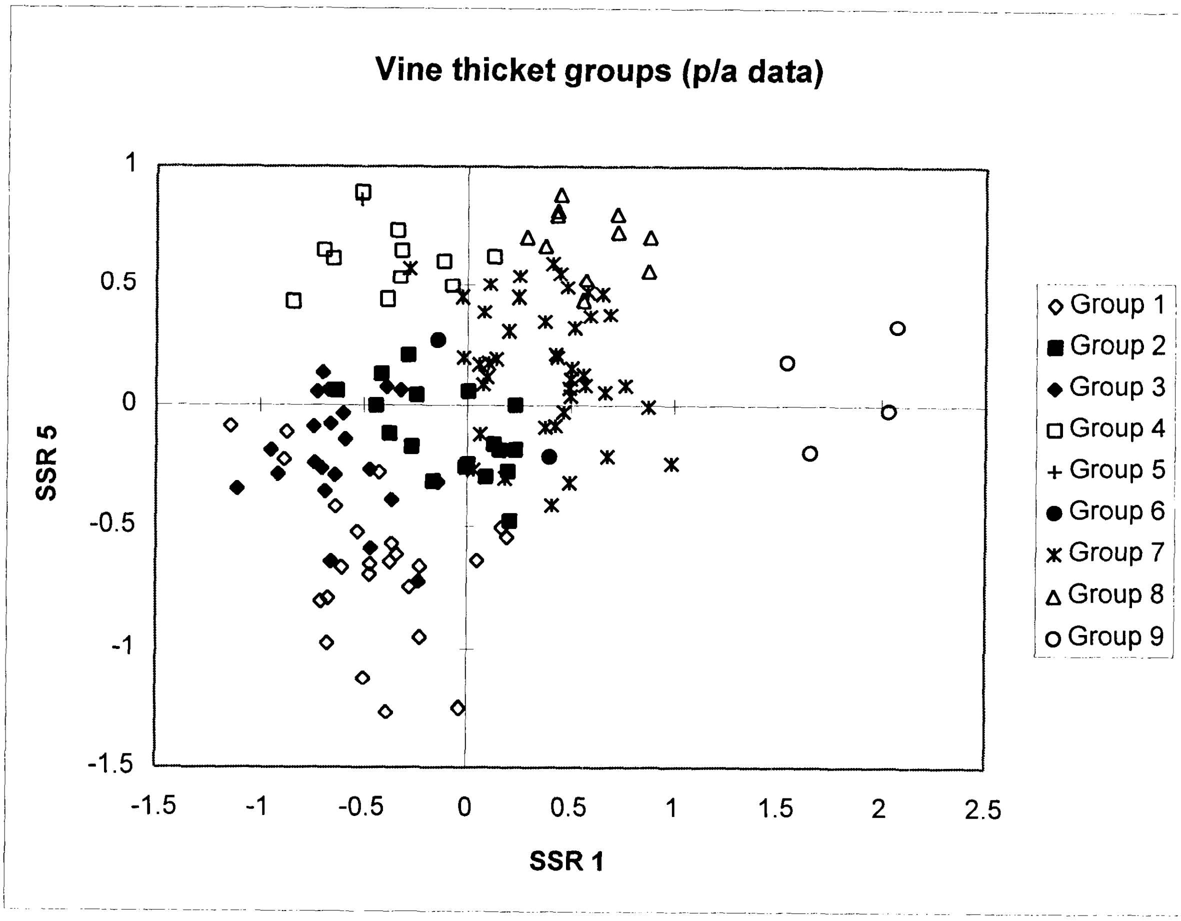


Figure 3.11 (a). DCA ordination of 136 vine thicket plots. Symbols show site-groups based on classification (B-C/UPGMA clustering) of presence/absence data.



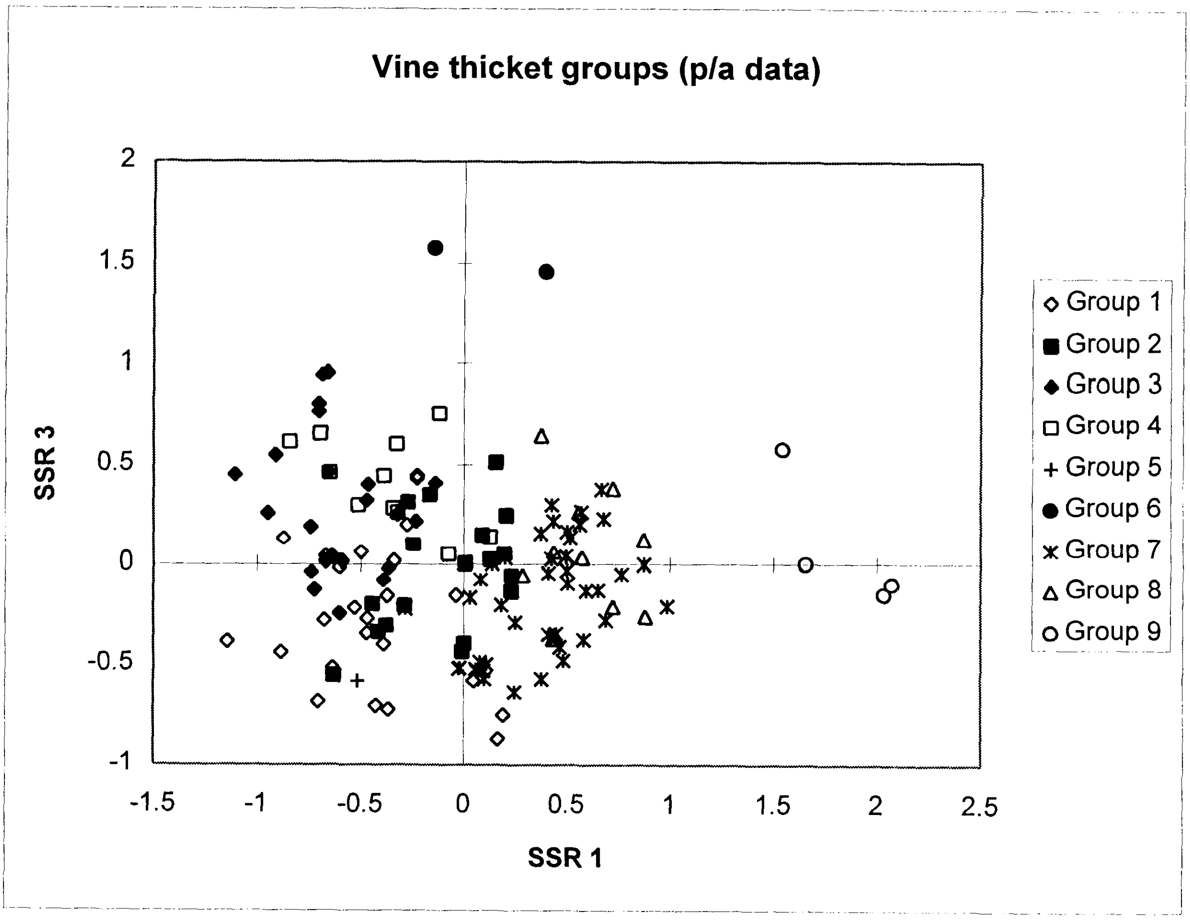


Figure 3.11 (b). SSR ordination of 136 vine thicket plots. Symbols show site-groups based on classification (B-C/UPGMA clustering) of presence/absence data.

Transposing the group labels to the ordination plots derived from presence/absence data (**Figure 3.12**) further emphasises the disparities between the agglomerative (**An 12**) and divisive (**An 13**) classifications.

3.6.2 Species classifications

Species classifications, using TWO-STEP/UPGMA clustering (Belbin 1992) were carried out on both presence/absence and abundance (cover) data.

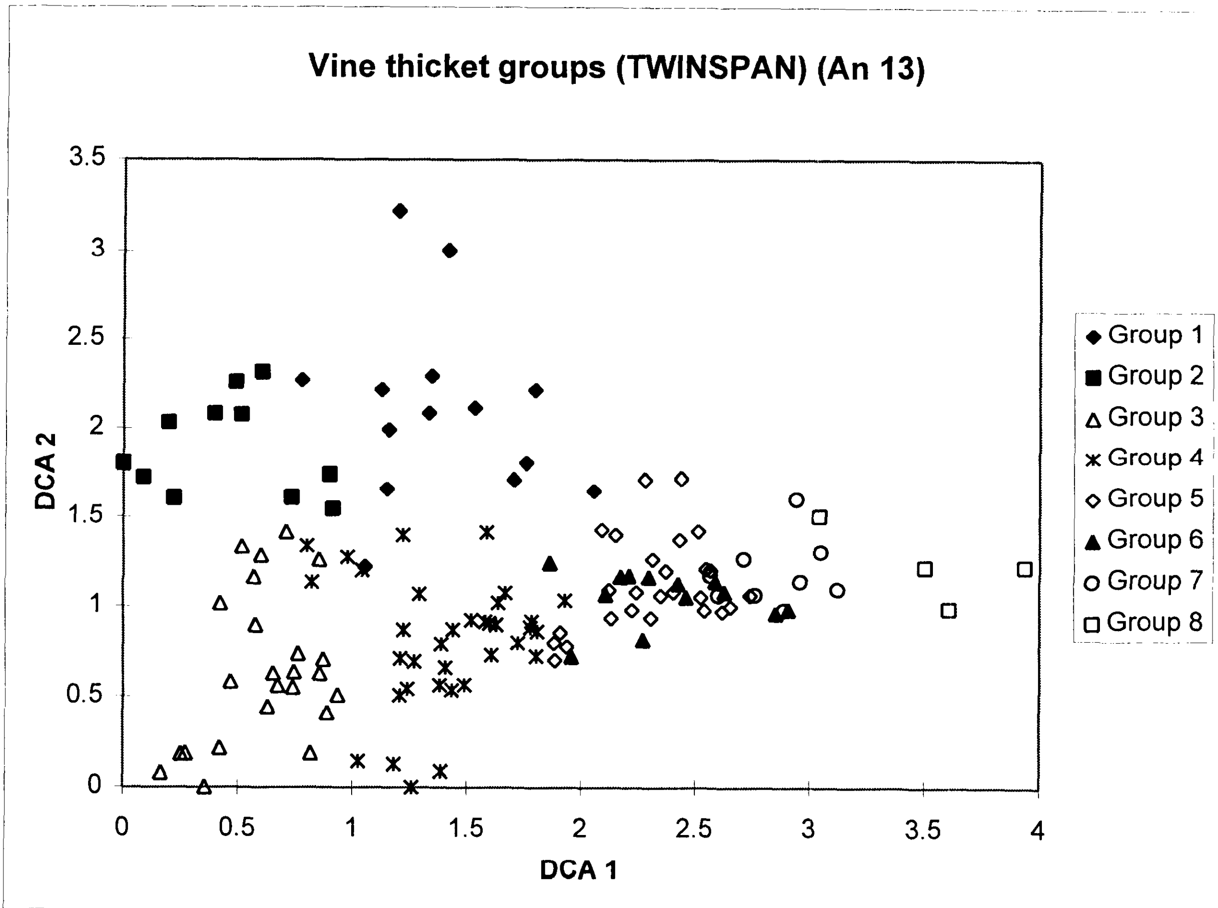
3.6.2.1 Presence/absence data

From the PATN default options, classification of the 211 tree, shrub and vine species initially produced 10 species-groups. This was reduced to 6 by amalgamating several small groups which mainly comprised a few species recorded from a limited number of sites.

The orientation of the 6 species-groups in (DCA) ordination space (see **Figure 3.13**) shows a large "core" group of vine thicket species, with surrounding smaller groups appearing to reflect geographic trends, with an east-west orientation along Axis 1 and a north-south trend in the direction of Axis 2.

The "core" group, group 5, comprises 74 species, which include all but two of the more widespread and frequent vine thicket species, i.e. those recorded from 50 or more plots (see **Table 3.14**). This group also includes several species which are particularly characteristic of the Auburn and Upper Dawson River district vine thickets (see below).

The second-largest group (group 2) consists of several species which are placed at the "western" end of Axis 1. They may be locally dominant in vine thickets, but do not occur widely through the study area. Thus it includes *Macropteranthes leichhardtii* (restricted to the Central Highlands), *Cadellia pentastylis* (recorded mostly in the Upper Dawson district), *Denhamia parvifolia* (Auburn district) and *Capparis shanesii* (Central Highlands/Nebo district), as well as *Acacia harpophylla, Capparis loranthifolia, Geijera parvifolia* and *Ventilago viminalis*, all of which are characteristic of the more inland and/or marginal vine thickets, but occur widely in other habitats.



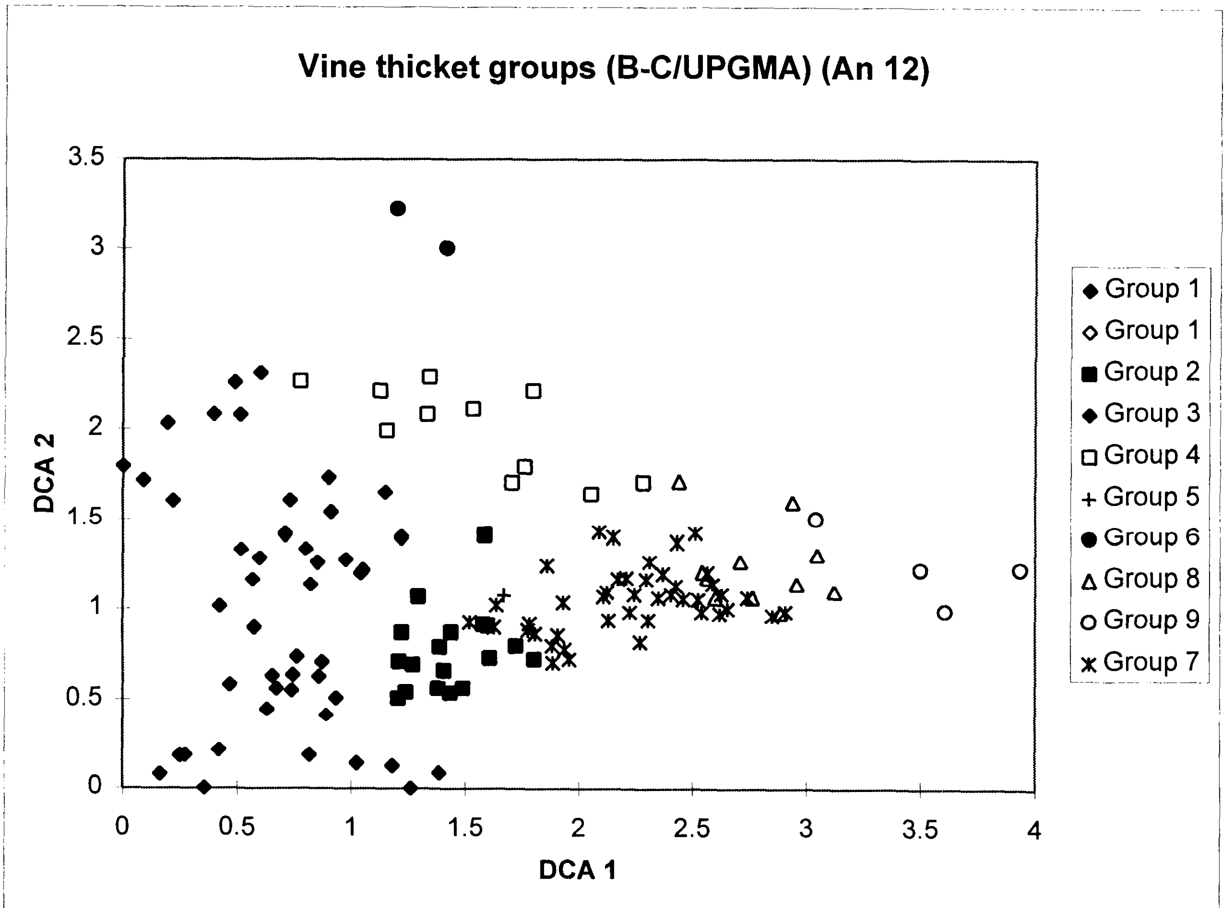
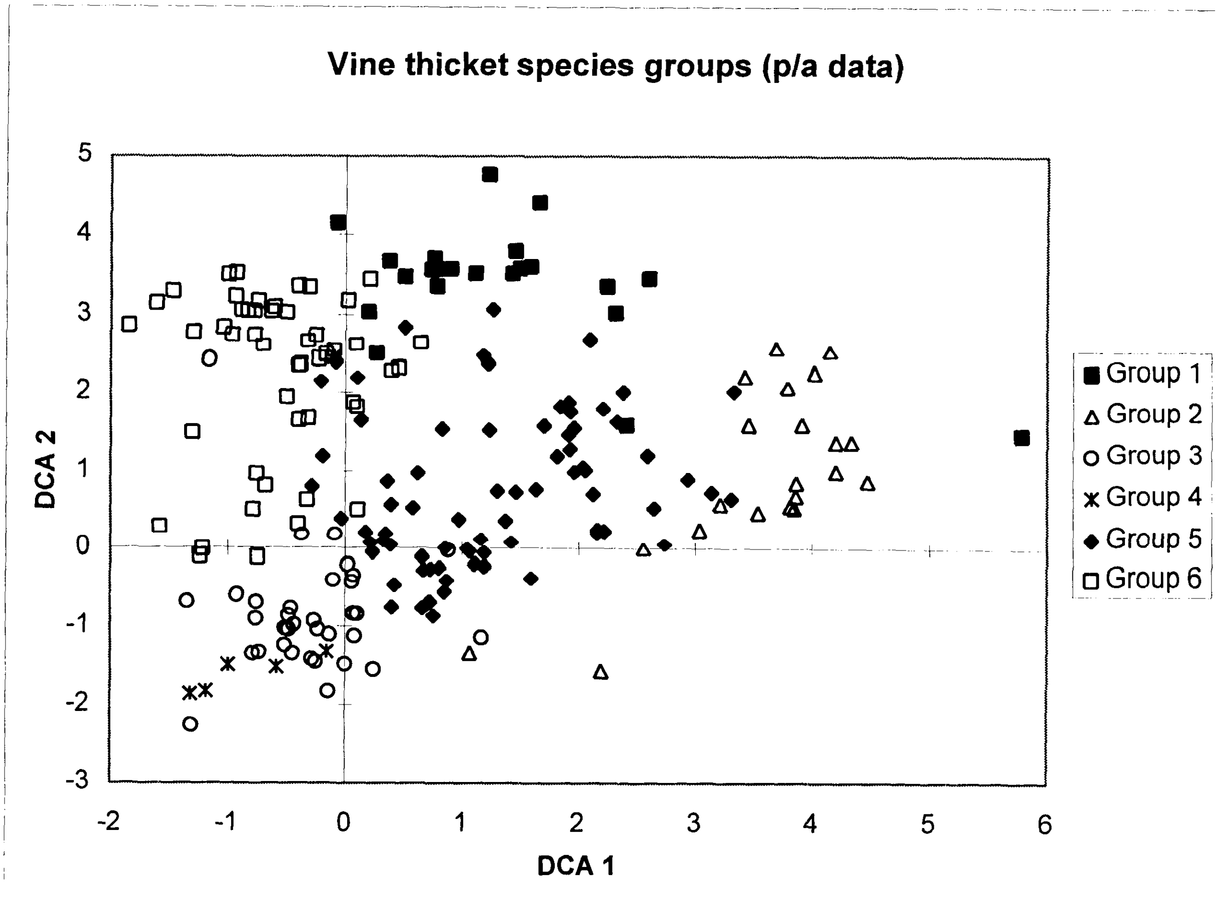


Figure 3.12. Ordination (DCA) of 136 vine thicket plots. Symbols show site-groups based on divisive (TWINSPAN) and agglomerative (B-C/UPGMA clustering) classifications of presence/absence data.



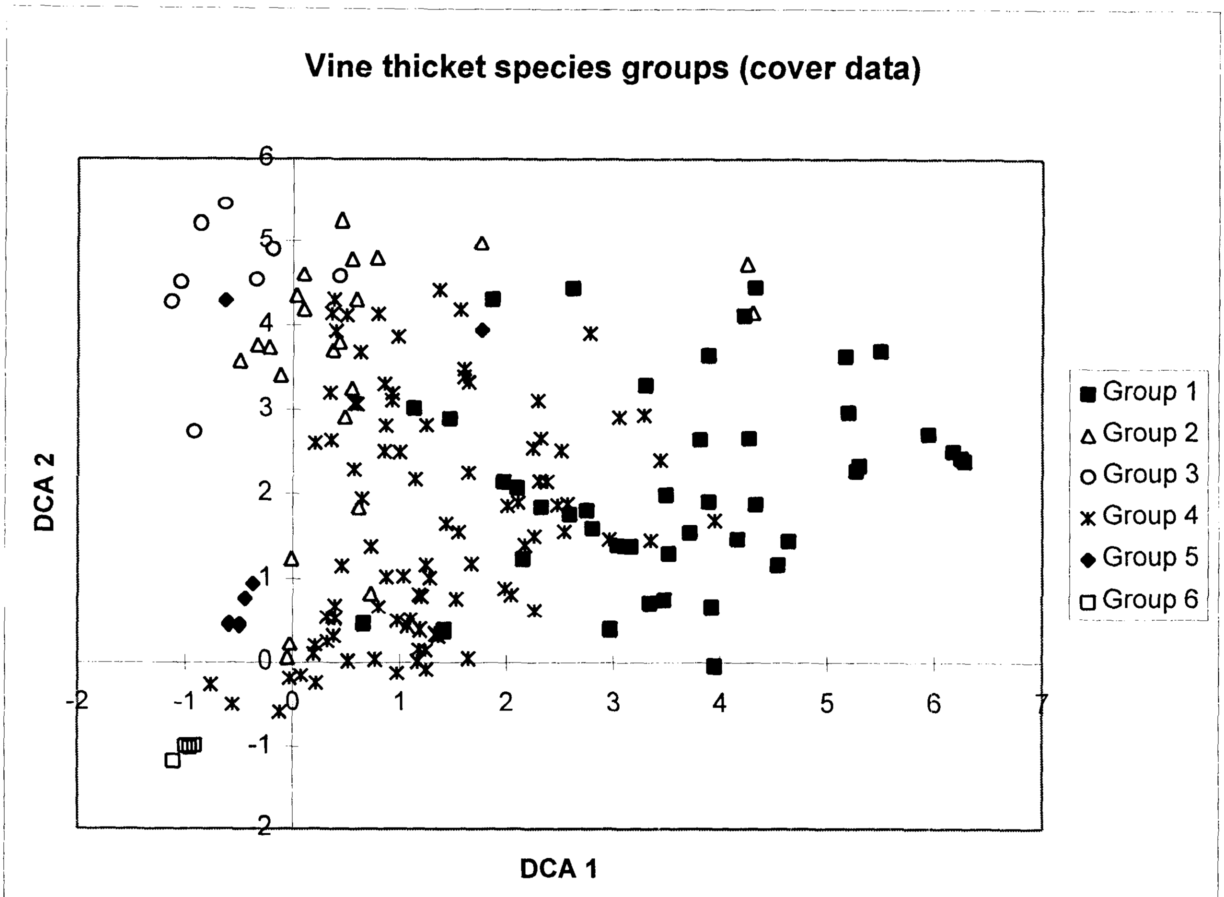


Figure 3.13. Ordination (DCA) of 211 vine thicket species (trees, shrubs and vines). Symbols indicate species-groups based on classifications (Two-Step/UPGMA clustering) of presence/absence and cover data.

Group 1 is located at the "northern" end of Axis 2 and contains species which are mostly characteristic of the more northern vine thickets, the most frequent including *Lysiphyllum hookeri, Ehretia grahamii, Cissus reniformis, Abutilon microcarpum, Capparis ornans, Flueggea leucopyrus* and *Gyrocarpus americanus.*

Species representative of the relatively moist communities of south-eastern Queensland make up most of group 3. Amongst these are *Parsonsia leichhardtii, Capparis sarmentosa, Casearia multinervosa, Acalypha capillipes and Planchonella cotinifolia* var. *cotinifolia.*

Group 6 includes 51 species which are mostly confined to, and/or are particularly characteristic of, the vine thicket of central coastal and subcoastal Queensland. There are also several species such as *Mallotus philippensis* and *Polyscias elegans* which are generally found in moister rainforest types.

The remaining group (group 4) comprises 8 species recorded only from the two most south-eastern sites, at Berlin Scrub (site 74) and Yarraman (75).

The results of this classification were used to order the species in frequency tables for vine thicket site-groups derived from both presence/absence and cover data (see **Table 3.25**).

3.6.2.2 Abundance (crown cover) data

Tree and shrub species (187 species) were also classified on their cover scores. At the 6-group level, the classification was far more uneven than for presence/absence data, with a single large group containing 91 species (group 4), and a second (group 1) with 44 species.

Ordination of the species-groups (**Figure 3.13**) shows similar broad north-south/east-west trends, but the groups are less sharply defined than those derived from the presence/absence data. There are several quite marked outliers.

The most frequent species in groups 1 and 4 are consistent with those in the equivalent groups (2 and 5) from the alternative (presence/absence) classification. Group 1 has a broader range of species, however, incorporating several northern vine thicket species, e.g. *Ehretia grahamii, Lysiphyllum hookeri* and *Flueggea leucopyrus*.

Other characteristic species from the northern and central Queensland vine thickets (i.e. presence/absence groups 1 and 6) are included in group 4, leaving mainly infrequent species (5 plots or fewer) in groups 2 and 3. Groups 5 and 6 comprise species recorded only from Berlin Scrub and Yarraman respectively.

Because of the unevenness and lack of geographical congruence of these species-groups, they were not considered a valid alternative for the ordering of species in frequency tables, although the preferred site classification (**An** 7) was based on species cover data.

3.7 Preferred classification and description of vine thicket community-types

Given the broad agreement between the geographical trends evident in most of the plot classifications (**Figures 3.9 and 3.10**), the classifications based on cover data were preferred to those based on relative importance because of the higher levels of agreement between site-pairs. Of the cover class-based analyses, **An** 7 (all tree and shrub species) appeared to produce the most clearly-defined groups with greatest within-site agreement.

Although this classification was adopted for the definition and description of vine thicket site-groups (community-types), the floristic classification based on presence/absence of tree, shrub and vine species (**An 12**) was considered to be equally satisfactory in terms of both geographical definition and within-site agreement. Moreover, the results of the floristic classification guided decisions on the appropriate level at which to define the cover-based groups.

Table 3.21 presents the preliminary 12-group definition for the preferred classification. From field experience, it was considered that some adjustments were warranted, and these appeared to be justified by examination of the ordination plots (DCA and SSR) (see **Figure 3.14**). Several plots were suspected to have been misclassified, and this was confirmed by nearest-neighbour analysis (see **Table 3.22**).

Plots 32A (Dipperu), 39A (Palmgrove) and 54A (Ka Ka Mundi) were therefore placed with the **Central Highlands** sites (generally dominated by *Macropteranthes leichhardtii*), plot 31A (Mt Hillalong) with the northern (**Nebo**) sites and 62C (Nantglyn) with plots 62A and 62B in the **South-east Queensland** site-group.

Table 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).

Group	No. Plots	Plots
1	18	01A 59A 59B 60A 60B 61A 62A 62B 64B 68A 68B 69A 69B 70A 70B 74A 74B 75A
2	4	06A 06B 21A 21B
3	2	22A 22B
4	16	23A 23B 26A 26B 27A 27B 29A 67A 67B 71A 71B 72A 72B
5	8	24A 25A 28A 28B 30A 30B 46A 46B
6	34	02A 02B 03A 03B 04A 04B 05A 09A 15A 15B 16A 16B 19A 20A 20B 31A 33A 36A 37A 37B 49A 49B 52A 52B 57A 57B 58A 62C 63B 64A 65A 65B 66A 66B
7	12	10A 10B 17A 17B 18A 39A 50A 50B 51A 51B 54A 63A
8	5	32A 44A 44B 45A 45B
9	2	47A 47B
10	2	48A 48B
11	24	07A 07B 08A 08B 12A 12B 13A 13B 14A 14B 34A 34B 38A 38B 39B 40A 40B 41A 41B 42A 53A 55A 55B 56A
12	6	11A 11B 35A 35B 43A 43B

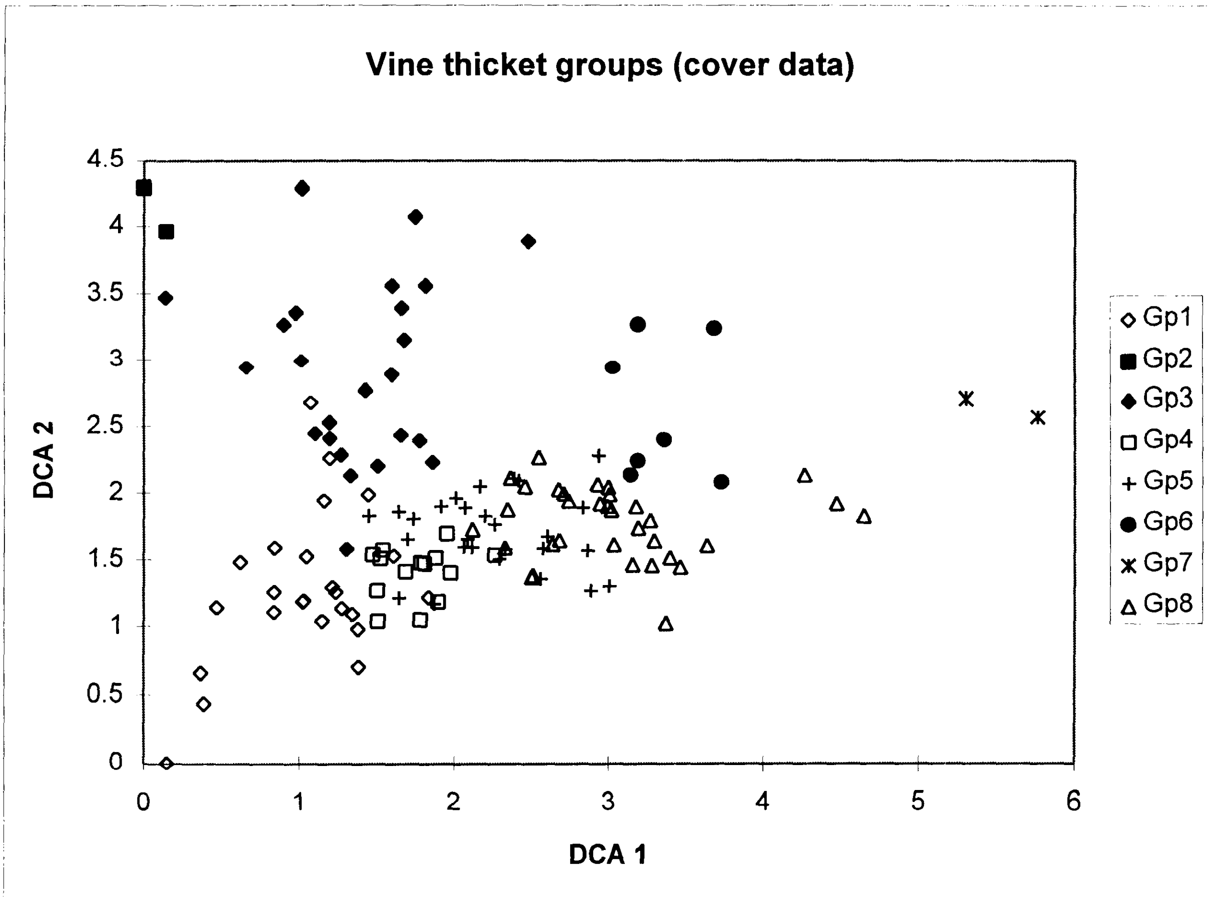
Table 3.22 Nearest-neighbours of (possibly) mis-classified vine thicket plots (using cover data).

Plot	Gp*	Nghbr 1	Nghbr 2	Nghbr 3	Nghbr 4	Nghbr 5	Gp (rev.)
9A	[6]	52B [6]	31A [6]	65A [2]	16B [6]	20A [2]	[6] 5#
31A	[6]	56A [11]	09A [6]	47B [8]	30A [5]	45B [9]	[8/9] 6
32A	[8]	11B [12]	45B [8]	41A [11]	40B [11]	54A [11]	[11] 8
39A	[7]	40B [11]	34B [11]	08B [11]	54A [7]	39B [11]	[11] 8
54A	[7]	13A [11]	13B [11]	14B [11]	08A [11]	50A [7]	[11] 8
62C	[6]	62B [1]	20B [6]	59B [1]	64B [1]	66A [6]	[1] 1
64A	[6]	64B [1]	02A [6]	02B [6]	01A [1]	66A [6]	[6] 4

* 12 - group classification. # 8 - group classification

Several of the preliminary groups were combined in the revised classification; these included 1 and 2 (**South-east Queensland**), 4 and 5 (**Central Queensland**), 6 and 7 (**inland southern Queensland**) 8 and 9 (**Nebo district**) and 11 and 12 (**Central Highlands**).

Of the inland southern Queensland stands, sites 2, 3, 4, 5, 19, 20 and 65 form a distinct geographical entity (**Auburn district**) and were separated from group 6, together with sites 9 (Gogango Range), 33 (Dululu), 64 (Reinkes Scrub) and 66 (western Bunya Mountains). On the other hand, although (preliminary) group 7 comprised mainly ooline (*Cadellia pentastylis*) stands, it did not warrant retention as a distinct site-group since there were other ooline-dominated plots in groups 6 (37A and B) and 11 (13A and B, 53A).



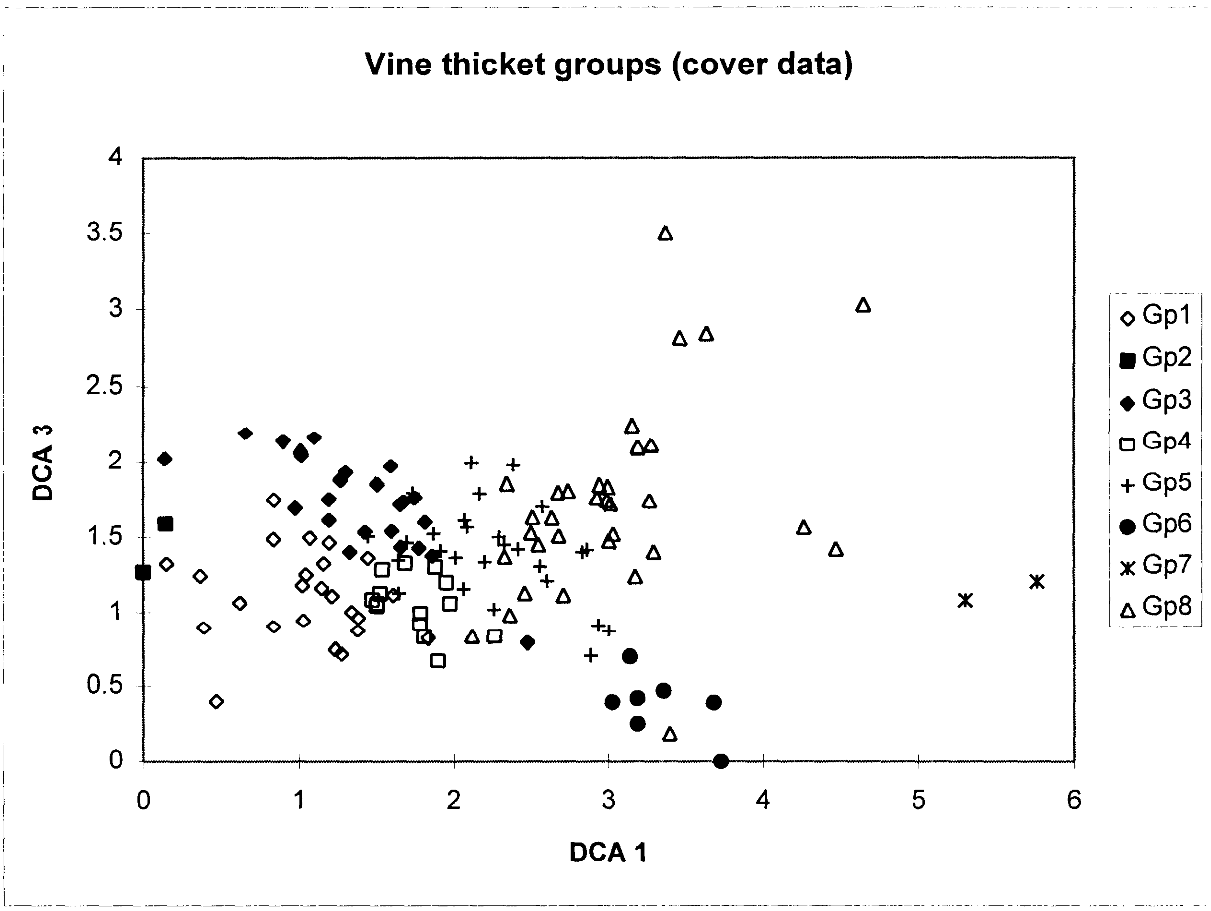
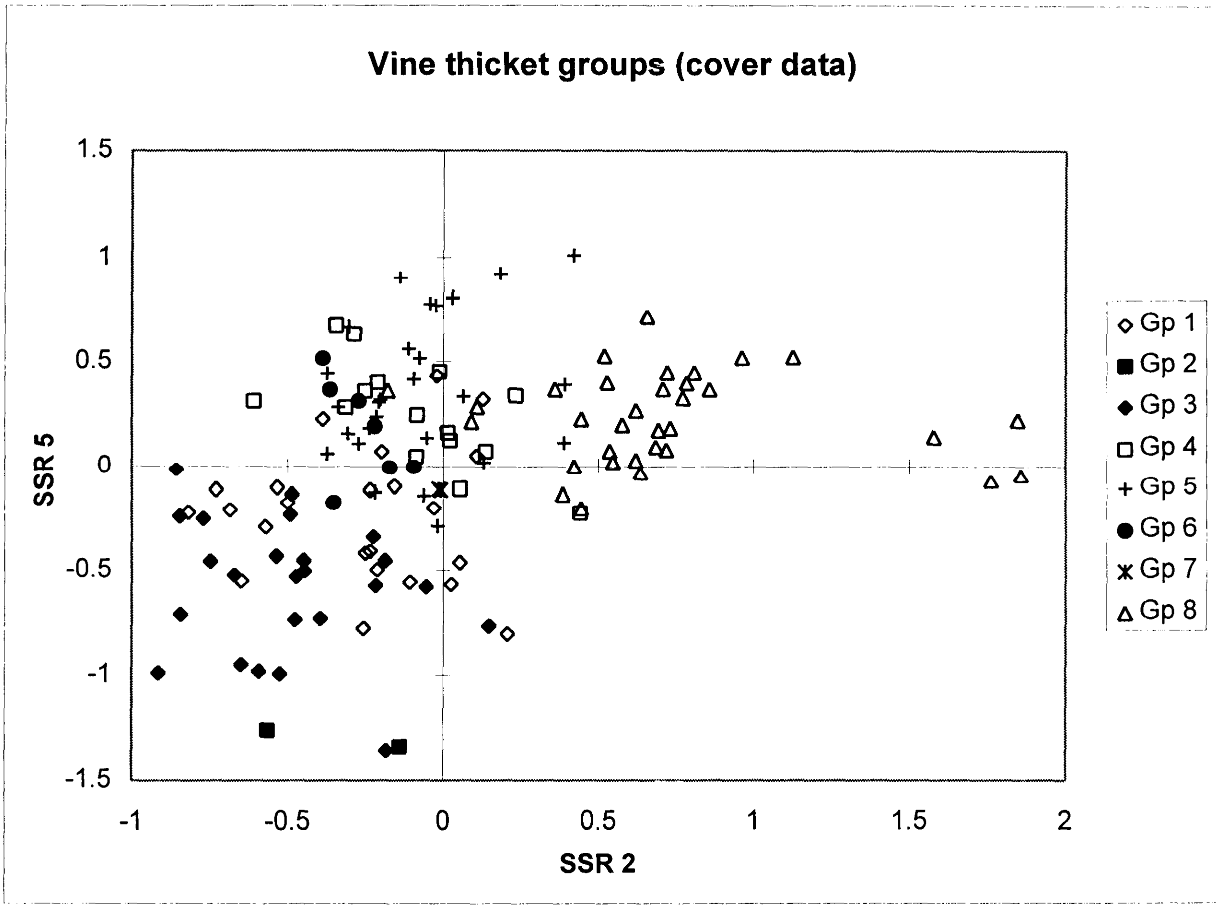


Figure 3.14 (a). DCA ordination of 133 vine thicket plots. Symbols show site-groups based on classification (B-C/UPGMA clustering) of cover data for tree and shrub species.



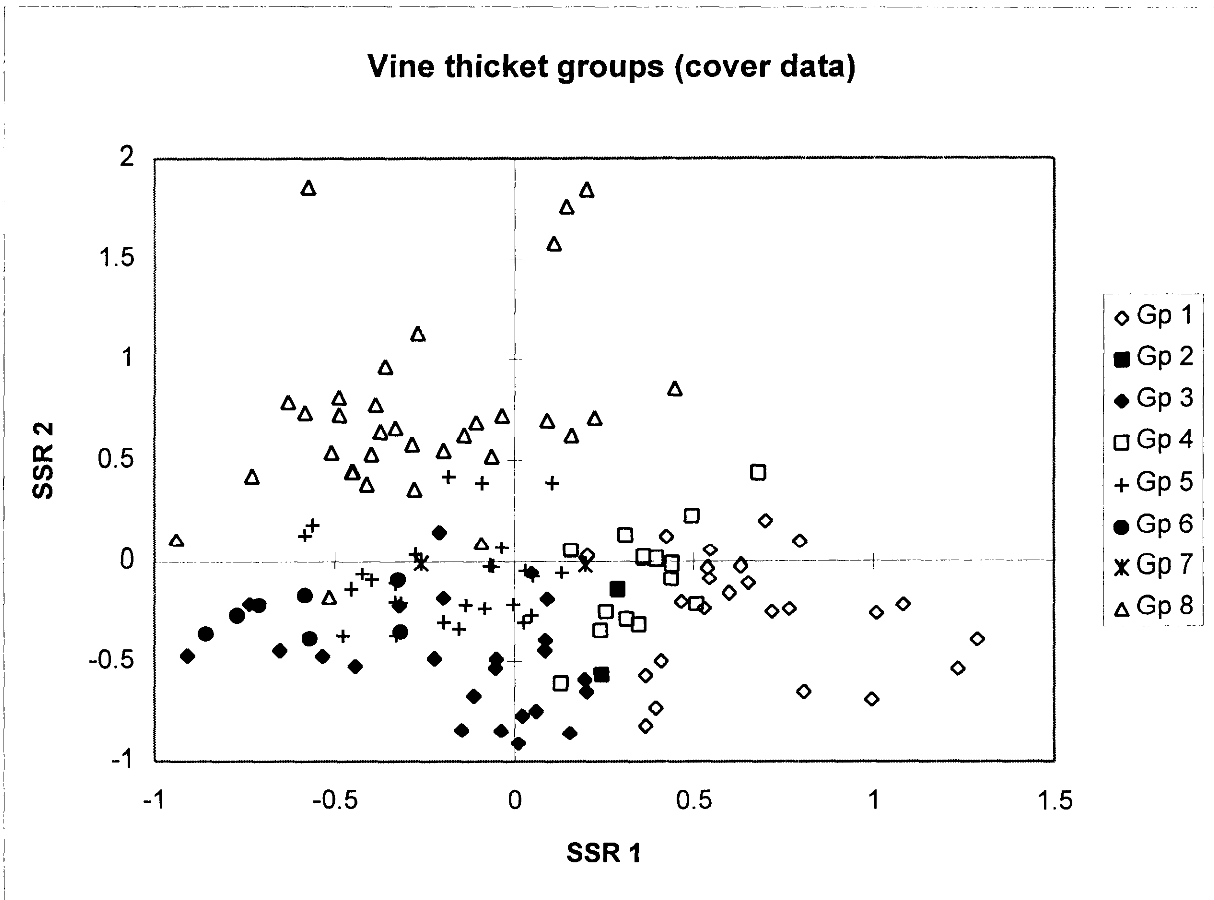


Figure 3.14 (b). SSR ordination of 133 vine thicket plots. Symbols show site-groups based on classification (B-C/UPGMA clustering) of cover data for tree and shrub species.

Two small groups, each comprising plots from a single site, namely 22 (Koolkoorum) and 48 (Mingela Bluff), have been retained as distinct entities. These groups combine with the nearest site-groups at relatively high levels of the classification, the 7-group level for Koolkoorum and 6-group level for Mingela Bluff. Plots 48A and 48B (i.e. Mingela Bluff) are closest to the northern (**Nebo**) site-group in the classificatory dendrogram and on the ordination plots, while 22A and 22B are closest to the **Central Queensland** site-group and are placed in this group by the floristic classification (i.e. **An 12**).

The revised classification is presented in **Figure 3.15** and **Table 3.23**, and the distribution of the vine thicket site-groups is shown in **Figure 3.16**. A resume of each site-group is provided below. It includes heights and cover % of the major strata (means and ranges), frequent species and those of highest fidelity in each group.

Ranges of cover values for trees species have been presented previously (in **Table 3.13**), and **Table 3.24** summarises mean cover values for 27 tree and shrub species (i.e. those with >5% cover for 1 or more site-groups). Frequency values (>10%) are shown in **Tables 3.25** (trees and shrubs) and **3.26** (vines and subshrubs). Groups 2 and 7, each comprising plots from a single site, have been omitted from these tables.

Fidelity was calculated as the proportion of records of a species in each site-group, again omitting groups 2 and 7. Of the 115 species occurring in 5 or more plots, 33 had fidelities of 70% or more. Group 1 had 14 of these species, group 3 twelve, 8 three, 5 two and groups 4 and 6 one species each.

Species-richness of each group was calculated as mean number of species per plot and as mean diversity (Shannon diversity index). Group 8 (Central Highlands) had a significantly lower number of species and a lower diversity ($P<0.001$) than groups 1, 3, 5, and 6. This latter value reflects both the smaller numbers of tree and shrub species and the dominance of most of the group 8 plots by *Macropteranthes leichhardtii*. The mean number of species in group 1 (South-eastern Queensland) is significantly higher than in all groups except group 3 (Central Queensland) ($P < 0.05$). There are no other consistent differences between groups.

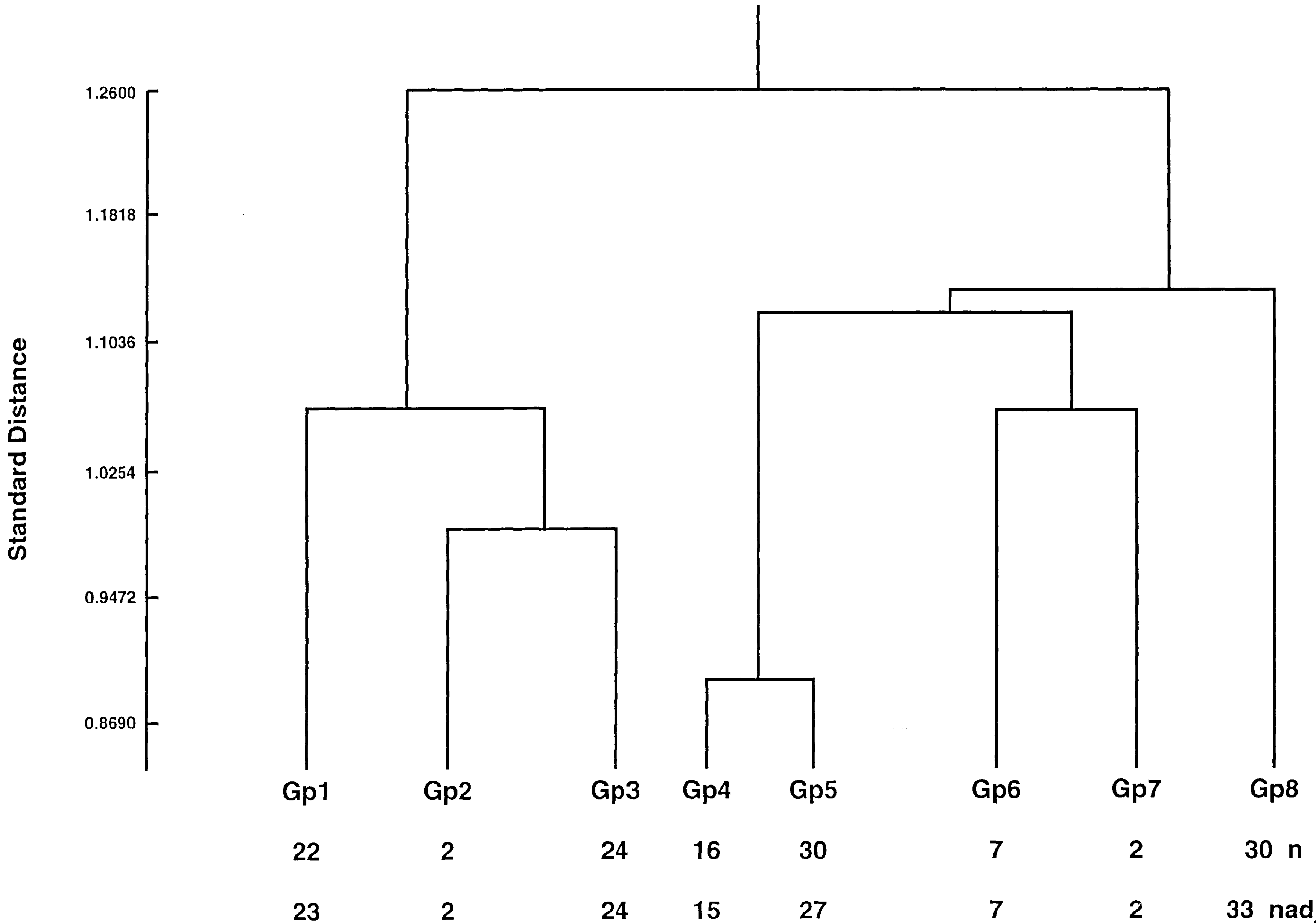


Figure 3.15 Modified classification of vine thickets plots based on standardised cover class data and Bray-Curtis coefficient with UPGMA clustering.

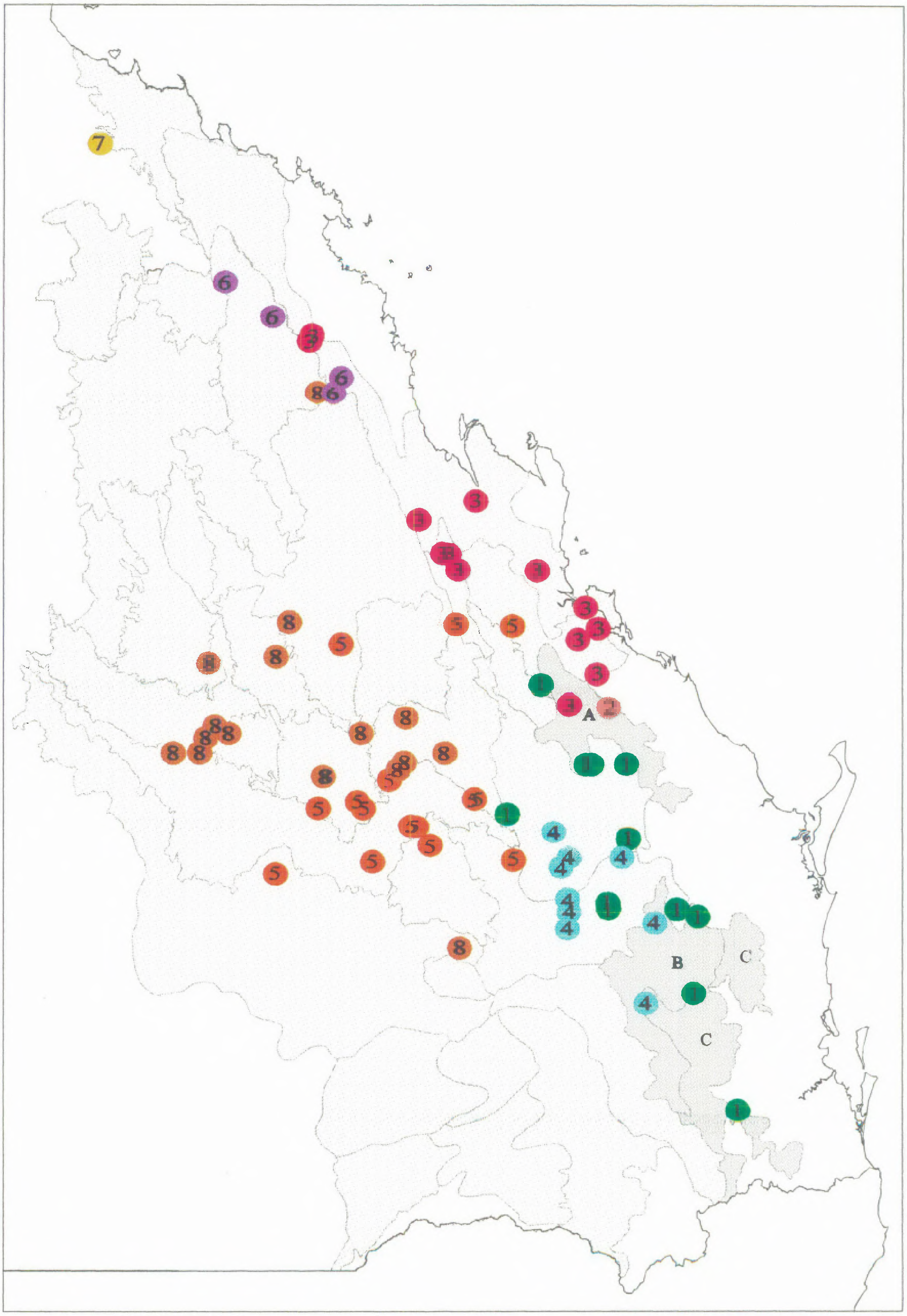


Figure 3.16 Distribution of vine thicket site-groups in central and southern Queensland. Groups based on classification (B-C/UPGMA clustering) of standardised cover data for tree and shrub species.

Table 3.23 Revised group definitions for vine thicket site-groups (community-types), based on Bray-Curtis / UPGMA classification of standardised cover data (An 7).

Group 1 (23 plots)	1A 6A 6B 21A 21B 59A 59B 60A 60B 61A 62A 62B 62C 64B 68A 68B 69A 69B 70A 70B 74A 74B 75A
Group 2 (2 plots)	22A 22B
Group 3 (24 plots)	23A 23B 24A 25A 26A 26B 27A 27B 28A 28B 29A 30A 30B 46A 46B 67A 67B 71A 71B 72A 72B 73A 73B 73C
Group 4 (15 plots)	2A 2B 3A 3B 4A 4B 5A 19A 20A 20B 64A 65A 65B 66A 66B
Group 5 (27 plots)	9A 10A 10B 15A 15B 16A 16B 17A 17B 18A 33A 36A 37A 37B 49A 49B 50A 50B 51A 51B 52A 52B 57A 57B 58A 63A 63B
Group 6 (7 plots)	31A 44A 44B 45A 45B 47A 47B
Group 7 (2 plots)	48A 48B
Group 8 (33 plots)	7A 7B 8A 8B 11A 11B 12A 12B 13A 13B 14A 14B 32A 34A 34B 35A 35B 38A 38B 39A 39 40A 40B 41A 41B 42A 43A 43B 53A 54A 55A 55B 56A

Table 3.24 Mean crown cover values (%) for tree and shrub species in 6 main vine thicket site-groups (mean cover > 5% for one or more groups).

	SITE - GROUP					
	1	**3**	**4**	**5**	**6**	**8**
No. of Plots	**23**	**24**	**15**	**27**	**7**	**33**
ACACFASC	1.5	0.9	3.5	5.6	0	1.4
ACALCAPI	7.5	0	0.2	0	0	0
ACALEREM	2.7	13.6	7.3	2.3	54.0	23.5
ARCHTHOZ	0	11.8	0	0	1.1	0.1
AUSTBIDW	7.7	3.7	0.9	1.5	0.2	0.1
BACKANGU	1.0	3.4	13.3	1.8	7.9	2.8
BACKKING	3.5	12.3	0	0	0.4	0
BRACAUST	0.8	5.4	1.4	0.8	4.1	0.9
BRACRUPE	2.2	1.4	4.5	6.4	3.6	4.5
CADEPENT	0	0	0	13.4	0	1.9
CARIOVAT	6.0	4.1	17.0	21.3	21.8	10.5
CASUCRIS	0.9	0	0.2	0.6	5.0	1.9
CROTINSU	5.9	2.8	10.2	15.4	0.9	8.9
CUPAPARV	6.5	0.3	0	0	0	0
DIOSHUMI	2.3	2.0	2.8	3.5	8.1	1.6
EXCODALL	12.0	8.6	2.6	6.6	0	0
FLINAUST	7.0	0.4	1.7	0	0.1	0.3
GEIJPANI	4.4	4.5	2.7	0.2	0	0
GEIJPARV	0.1	0	0.1	8.4	0	6.0
GREWSCAB	0	0.8	0	0	5.1	0
LYSIHOOK	0	1.6	0	0.8	17.5	0.9
MACRLEIC	0	0	0	3.8	0	43.4
NOTEMICR	3.2	1.9	6.1	3.6	2.1	3.8
OWENVENO	12.9	2.4	5.3	4.6	0	0
PLANCOPU	2.7	11.5	13.8	17.4	17.6	4.6
STRYAXIL	4.2	12.0	0.2	0	1.6	0
TERMOBLO	0	0.1	0	0	12.9	0

Table 3.25 Two-way table of vine thicket site-groups and tree and shrub species with frequenc of >0.40 in 1 or more site-groups (excluding groups 2 and 7).

	SITE-GROUPS					
	1	3	4	5	6	8
No. of Plots	23	24	15	27	7	33
ABUTMICR		0.167		0.074	0.429	
FLUELEUC		0.208		0.037	0.429	0.061
LYSIHOOK		0.125		0.074	1	0.121
TERMOBLO		0.042			0.857	
GYROAMER		0.25			0.429	
GREWSCAB		0.083			0.714	
APOPANOM				0.556		0.364
CAPPLORA	0.087	0.042	0.200	0.926	0.143	0.606
GEIJPARV	0.130		0.133	0.926		0.727
CADEPENT				0.407		0.091
MACRLEIC				0.111		0.939
VENTVIMI				0.111		0.424
DENHOLEA		0.042		0.074	0.571	0.333
ACALCAPI	0.696		0.067			
ARYTFOVE	0.478		0.067			
PLANCOCO	0.565		0.133			
CASEMULT	0.652		0.267	0.037		
CUPAPARV	0.565	0.042	0.067			
CANTBUXI	0.391		0.467			
PAVEAUST	0.435	0.125		0.037		
ACACFASC	0.391	0.292	0.333	0.741		0.273
CANTVACC	0.826	0.208	0.733	0.556		0.515
ACALEREM	0.304	0.917	0.800	0.630	1	0.576
CITRSPIN	0.348	0.792	0.467	0.926	0.857	0.848
PLANCOPU	0.348	0.958	0.867	0.963	1	0.697
CARIOVAT	0.870	0.875	0.933	1	0.714	0.727
NOTEMICR	0.783	0.708	1	0.852	0.714	0.697
DIOSHUMI	0.609	0.667	0.800	0.815	0.857	0.545
DIPLIXOR	0.522	0.708	0.467	0.741	0.714	0.545
CROTINSU	0.739	0.458	0.867	0.889	0.286	0.667
BREYOBLO	0.304	0.375	0.400	0.481	0.429	0.333
ALECDIVE	0.261	0.250	0.667	0.926	0.714	0.727
EHREMEMB	0.348	0.333	0.733	0.926	0.571	0.758
BRACRUPE	0.304	0.125	0.600	0.556	0.286	0.545
OPUNTOME	0.087	0.292	0.133	0.407	0.429	0.455
CANTBRIG	0.174		0.533	0.370	0.286	0.182
ALSTCONS	0.522	0.125	0.533	0.148	0.143	0.364
BACKANGU	0.348	0.125	0.733	0.259	0.286	0.333
GEIJSASA	0.217	0.250	0.933	0.037	0.714	
ALECCONN	0.435	0.500	0.200	0.444	0.857	0.182
CANTODOR	0.478	1	0.267	0.593	0.857	0.333
TURRPUBE	0.565	0.792	0.400	0.481		0.152
BRIELEIC	0.217	0.208	0.533	0.296	0.143	0.030
BRACAUST	0.174	0.458	0.333	0.185	0.571	0.152
CROTPHEB	0.130	0.458	0.333	0.185	0.714	0.424
ALYXRUSC	0.739	0.625	0.133		0.286	0.030
DIOSGEMI	0.652	0.917	0.200			
DRYPDEPL	0.826	0.708	0.133	0.148	0.429	0.030
STRYAXIL	0.522	1	0.133	0.074	0.429	

Table 3.25 (cont.)

	SITE-GROUPS					
	1	3	4	5	6	8
No. of Plots	**23**	**24**	**15**	**27**	**7**	**33**
CROTACRO	0.478	0.500	0.067			
AUSTBIDW	0.957	0.792	0.467	0.296	0.429	0.030
CAPPARBO	0.696	0.542	0.800	0.074		
ELATXYLO	0.565	0.500	0.533	0.407	0.286	
EXCODALL	0.652	0.625	0.267	0.407		0.030
MELIERYT	0.391	0.375	0.600	0.074		
OWENVENO	0.696	0.292	0.533	0.296		
GREVHELM	0.478	0.375	0.267			
ATALSALI	0.696	0.208	0.867	0.296	0.286	0.212
DENHPITT	0.478	0.250	0.467	0.444		0.061
FLINCOLL	0.783	0.083	0.867	0.444		0.212
CASSAUAN	0.609	0.042	0.133	0.481	0.286	0.091
ERYTAUST	0.348	0.458	0.867	0.444	0.571	0.091
CITRLINE	0.696	0.083	0.800			
MAYTDISP	0.609	0.167	0.467	0.111		0.121
MAYTBILO	0.261	..083	0.467	0.037		0.030
SIPHAUST	0.565	0.125	0.200	0.296	0.143	0.061
FLINAUST	0.435	0.083	0.267		0.143	0.091
BURSINCA	0.261	0.042	0.733	0.074		
GEIJPANI	0.304	0.417	0.133	0.074		
POLYELEG	0.217	0.458	0.067	0.111		
MURROVAT	0.217	0.625		0.074	0.143	
BACKKING	0.130	0.542			0.143	
ARCHTHOZ		0.792			0.143	0.030
PLEITIMO		0.542			0.143	

Table 3.26 List of vine thicket subshrub* and vine species with frequency of >0.35 in 1 or more s (excluding groups 2 and 7).

		SITE - GROUP					
		1	3	4	5	6	8
	No. of Plots	**23**	**24**	**15**	**27**	**7**	**33**
Subshrubs	ABUTOXAC	0.565	0.625	0.667	0.852	0.143	0.741
	ANCIUNCI	0.783	1.000	0.933	0.815	1.000	0.556
	CALOHYGR	0.391	0.042	0.067	0	0	0
	DEERAMAR	0.391	0.208	0.267	0.333	0.143	0.333
	OLEACANE	0.043	0.042	0.400	0.259	0	0.037
	RIVIHUMI	0.391	0.292	0	0.037	0.143	0
	SOLACORI	0.478	0	0.533	0	0	0
	SOLAPARV	0	0.083	0	0.667	0.143	0.815
	SOLASEMI	0.174	0.250	0.400	0.519	0	0.222
	SOLASTEL	0.783	0.250	0.867	0.259	0.286	0
	SPARJUNC	0.652	0.250	0.933	0.778	0	0.852

* The grass *Ancistrachne uncinulata* is listed with the subshrubs.

Table 3.26 (cont.)

		SITE - GROUP					
		1	3	4	5	6	8
	No. of Plots	**23**	**24**	**15**	**27**	**7**	**33**
Vines	AUSTBLAC	0.522	0.208	0	0	0	0
	CAPPLASI	0.087	0	0	0.481	0.429	0.630
	CAPPSARM	0.696	0	0.067	0	0	0
	CISSOBLO	0.217	0.542	0.200	0	0	0
	CISSOPAC	0.435	0.583	0.600	0.889	0.714	0.852
	CYNABOWM	0.304	0.333	0.400	0.444	0	0.111
	DIOSTRAN	0.652	0.750	0.067	0.185	0.286	0
	GLOSHEMI	0.522	0.875	0.133	0.148	0.571	0.185
	GYMNPLEI	0.217	0.042	0.400	0.148	0	0
	JASMDILI	0	0	0	0.148	0	0.444
	JASMDIRA	0.739	0.750	0.600	0.667	0	0.407
	JASMSIAU	0.783	0.417	0.933	0.481	0.143	0.148
	MALASCAN	0.609	0.375	0.267	0.185	0.143	0.037
	MELOLEIC	0.870	0.542	0.333	0.074	0	0
	PANDPAND	0.130	0.208	0.400	0.111	0	0.296
	PARSEUCA	0.087	0	0.200	0.481	0	0.556
	PARSLANC	0.348	0.292	0.800	0.630	0.857	0.704
	PARSLEIC	0.696	0.083	0.200	0	0	0
	PARSPLAE	0.174	0.375	0.067	0.037	0.429	0.037
	PASSAURA	0.304	0.250	0.467	0.148	0	0.074
	SECAELLI	0.609	0.875	0.667	0.815	0.714	0.667
	SMILAUST	0.130	0.417	0	0	0	0
	SOLASEAF	0.217	0.333	0.333	0.111	0.429	0
	TINOSMIL	0.348	0.417	0.400	0.407	0.571	0.407

3.7.1 Vine thicket site-groups

Group 1. South-eastern Queensland [plots 1A, 6A, 6B, 21A, 21B, 59A, 59B, 60A, 60B, 61A, 62A, 62B, 62C, 64B, 68A, 68B, 69A, 69B, 70A, 70B, 74A, 74B, 75A]

This group extends from the Lockyer district west of Brisbane to the Callide Range in the Port Curtis district, with an outlier at Cracow (site 6). It intergrades with group 2 (e.g. the Dan Dan and Rundle Range sites) and also with group 4 to the west; e.g. of the two plots at Reinkes Scrub, the less exposed, south-facing plot (64B) falls within group 1, while the drier, ridge-top plot (64A) has been placed in group 4 (Auburn district).

Structurally, several of these sites approach (araucarian) (low) microphyll vine forest, and this is also reflected in their floristic composition. Several of the characteristic species for this group (e.g. *Arytera foveolata, Acalypha capillipes, Planchonella cotinifolia* var. *cotinifolia, Cupaniopsis* *parvifolia*) and less frequent species such as *Diospyros australis, Cleistanthus cunninghamii, Cryptocarya triplinervis* and *Mallotus claoxyloides* are typical araucarian vine forest species.

Parent materials range from basalt (Yarraman, Windera) through intermediate volcanics and metamorphics (Nangur and Reinkes Scrub) to fine-grained sedimentary rocks (e.g. Evergreen Formation at Coominglah) and lateritised sediments at Yarrol. There are no clear subgroups within group 1 and no apparent relationships with the different parent materials.

Summary structure:

Emergent layer: (height) 15-25m
Canopy: 10-15(-18)m; (cover) 30-50(-70)%.
Tall shrubs/low trees: 7-10(-12)m; 20-35(-50)%
Tall shrubs: 3-6m; 20-30(-40)%
Low shrubs: 1-3m; 10-25(-50)%
Ground stratum: <1m; 5-10(-25)%

Mean plot area: 370 m2 (240-534.5)

Mean altitude (m): 371 (160-480)

Mean basal area:. 28.3 m^2/ha (17.5-46.4)

No. stems /ha: 2982 (1066-4766)

Mean species counts: 14 (T) 11 (TS) 11 (LS) 5 (SS) 13 (V)

Total: 54 (38-71)

Mean diversity (Shannon Index): 2.749 (2.249-3.109)

Evenness: 0.767 (0.638-0.832)

Frequent species:

Tree species	Freq.	M.Cov.
AUSTBIDW	0.96	7.72
DRYPDEPL	0.83	1.26
NOTEMICR	0.78	3.22
FLINCOLL	0.78	2.07
CROTINSU	0.74	5.87
OWENVENO	0.70	12.93
CAPPARBO	0.70	3.37
ATALSALI	0.70	3.07
EXCODALL	0.65	11.98
DIOSGEMI	0.65	2.09
DIOSHUMI	0.61	2.30
MAYTDISP	0.61	1.28
CASSAUAN	0.61	1.15
CUPAPARV	0.57	6.54
PLANCOCO	0.57	3.50
EXOCLATI	0.57	0.93
SIPHAUST	0.57	0.91
ELATXYLO	0.57	0.80
STRYAXIL	0.52	4.22
ALSTCONS	0.52	0.59
ARYTFOVE	0.48	2.85
GREVHELM	0.48	2.35

Shrub species	Freq.	M.Cov.
CARIOVAT	0.87	6.04
CANTVACC	0.83	4.54
ALYXRUSC	0.74	0.80
ACALCAPI	0.70	7.52
CITRLINE	0.70	0.78
CASEMULT	0.65	1.61
TURRPUBE	0.57	2.26
DIPLIXOR	0.52	0.26
CROTACRO	0.48	2.78
PAVEAUST	0.43	0.22

Vines	Freq.
MELOLEIC	0.87
JASMSIAU	0.78
JASMDIRA	0.74
CAPPSARM	0.70
PARSLEIC	0.70
DIOSTRAN	0.65
MALASCAN	0.61
SECAELLI	0.61
AUSTBLAC	0.52
GLOSHEMI	0.52

Subshrub /ground layer	Freq.
ANCIUNCI	0.78
SOLASTEL	0.78
SPARJUNC	0.65
ABUTOXAC	0.57
SOLACORI	0.48
CALOHYGR	0.39
DEERAMAR	0.39
RIVIHUMI	0.39

CANTODOR	0.48	1.74
DENHPITT	0.48	1.17
FLINAUST	0.43	7.02
ALECCONN	0.43	0.76

High fidelity species (ie. >70% of records in group):
ACALCAPI, ARYTFOVE, ARYTMICR, CANTCOPR, CASEMULT, CUPAPARV, PAVEAUST, PLANCOCO, PREMLIGN, CAPPSARM, MORIACUT, PARSLATI, PARSLEIC, CALOHYGR.

Group 2. Koolkoorum [plots 22A, 22B]

This site, as noted earlier, is unique, with a major disjunct population of *Fontainea venosa*, and is also the only site in the present survey from which *Atalaya calcicola* was recorded (the species also occurs. at Mt Etna near Rockhampton). Its overall floristic, as well as geographic, affinities are with group 3 (Central Queensland).

Major species:

Tree species	M.Cov.
BOSIMEDI	25.30
GEIJPANI	25.00
DENDPHOT	11.30
FONTVENO	11.30

Shrub species	M.Cov.
MURROVAT	19.00

Group 3. Central Queensland [plots 23A, 23B, 24A, 25A, 26A, 26B, 27A, 27B, 28A, 28B, 29A, 30A, 30B, 46A, 46B, 67A, 67B, 71A, 71B, 72A, 72B, 73A, 73B, 73C]

The sites in this group are located mostly between Monto and the Marlborough district north of Rockhampton. There are outliers on basic volcanics near Nebo (Mt Britten) and a plot (62A) at Nantglyn near Mundubbera was initially placed here because it is dominated by *Macropteranthes leiocaulis* and *Backhousia kingii*, two of the characteristic species for this group.

Other characteristic species in this group are *Archidendropsis thozetiana, Homalium alnifolium, Pleiogynium timorense* and *Sterculia quadrifida*, also the shrub *Murraya ovatifoliolata. Brachychiton australis* is relatively more frequent than *B. rupestris* in these communities.

Geological substrates are quite diverse, but intermediate to acid volcanics, metamorphics and minor sediments predominate. Several sites are rocky, the extreme being the footslopes of Mt O'Connell (site 28) which is granitic in origin (adamellite). Limestone is present in some locations, e.g. Bracewell (25).

There appear to be no logical subgroups within group 3. There is a tendency at lower levels of the classification for site-pairs to be separated, e.g. replicate plots from site 67 ("Cerberus") and site 73 (Goodedulla National Park) on the Boomer Range are placed in different subgroups.

Summary structure:

Emergent layer: 13-15(-20)m
Canopy: 10-12(-15)m; 25-45(-60)%.
Subcanopy: 7-10m; 25-40%.
Tall shrubs: 3-4(-8)m; 20-35(-40)%
Low shrubs: 1-2(-3)m; 15-35%
Ground stratum: <1m; 5-15(-30)%

Mean plot area: 484 m2 (263-868)

Mean altitude (m): 215 (40-440)

Mean basal area:. 23.9 m^2/ha (9.1-76.3)

No. stems /ha: 2642 (1399-4592)

Mean species counts: 12 (T) 12 (TS) 8 (LS) 3 (SS) 12 (V)

Total: 47 (30-66)

Mean diversity (Shannon Index): 2.674 (2.029-3.225)

Evenness: 0.774 (0.603-0.911)

Frequent species:

Tree species	Freq.	M.Cov.
STRYAXIL	1.00	11.98
CANTODOR	1.00	4.58
PLANCOPU	0.96	11.48
DIOSGEMI	0.92	1.96
ARCHTHOZ	0.79	11.75
AUSTBIDW	0.79	3.67
CITRSPIN	0.79	1.33
NOTEMICR	0.71	1.90
DRYPDEPL	0.71	1.56
DIOSHUMI	0.67	2.02
EXCODALL	0.63	8.56
BACKKING	0.54	12.27
PLEITIMO	0.54	4.65
CAPPARBO	0.54	1.96
ELATXYLO	0.50	0.75
ALECCONN	0.50	0.75
BRACAUST	0.46	5.44
CROTINSU	0.46	2.75
POLYELEG	0.46	0.85
ERYTAUST	0.46	0.54
GEIJPANI	0.42	4.46

Shrub species	Freq.	M.Cov.
ACALEREM	0.92	13.65
CARIOVAT	0.88	4.08
TURRPUBE	0.79	2.29
DIPLIXOR	0.71	0.77
MURROVAT	0.63	1.90
ALYXRUSC	0.63	1.23
CROTACRO	0.50	3.06
CROTPHEB	0.46	0.33

Vines	Freq.
SECAELLI	0.88
GLOSHEMI	0.88
JASMDIRA	0.75
DIOSTRAN	0.75
CISSOPAC	0.58
MELOLEIC	0.54
CISSOBLO	0.54
JASMSIAU	0.42
TINOSMIL	0.42
SMILAUST	0.42

Subshrub /ground layer	Freq.
ANCIUNCI	1.00
ABUTOXAC	0.63

High fidelity species (ie. >70% of records in group):
ARCHTHOZ, ATALRIGI, BACKKING, CASSMELA, CUPAWADS, EUROFALC, GUETPUTA, HOMAALNI, MALLCLAO, PLEITIMO, TERMPORP, CAPPORNA.

Group 4. Auburn district. [plots 2A, 2B, 3A, 3B, 4A, 4B, 5A, 19A, 20A, 20B, 64A, 65A, 65B, 66A, 66B]

This group was initially placed within group 5 in the classification, but forms a distinct geographical subgroup. The group also includes two outliers, site 66 (western Bunya Mountains) and plot 64A (Reinkes Scrub near Proston).

Characteristic species for this group include *Backhousia angustifolia, Denhamia parvifolia* (a threatened species confined to the eastern and southern Burnett district), *Canthium buxifolium* and *Citriobatus linearis*. *Geijera salicifolia* var. *salicifolia* is also relatively frequent.

Substrates are predominantly fine-grained sediments, especially shales and claystones (e.g. Evergreen Formation) with the Bunya Mountains site occurring on basalt.

The Wonga Hills plot (5A) within this group had the largest number of species (19) recorded in a 32-nearest neighbours sample during this study.

Summary structure:
Emergent layer: 15-20(-25)m; 5-10%
Canopy: 8-12(-15)m; 30-45(-60)%.
Subcanopy (tall shrubs/low trees): 4-8m; 40-50(-60)%
Low shrubs: 1-2(-4)m; 15-25(-40)%
Ground stratum: <1m; 5-10%

Mean plot area: 494 m2 (307-715)

Mean altitude (m): 403 (160-640)

Basal area:. Mean 29.3 m^2/ha (11.6-62.7)

No. stems /ha: 2008 (1316-3413)

Mean species counts: 13 (T) 9 (TS) 7 (LS) 5 (SS) 9 (V)

Total: 43 (29-57)

Mean diversity (Shannon Index): 2.670 (1.927-3.114)

Evenness: 0.780 (0.606-0.904)

Frequent species:

Tree species	Freq.	M.Cov.
NOTEMICR	1.00	6.07
GEIJSASA	0.93	4.03
PLANCOPU	0.87	13.83
CROTINSU	0.87	10.17
FLINCOLL	0.87	3.47
ATALSALI	0.87	2.07

Shrub species	Freq.	M.Cov.
CARIOVAT	0.92	14.60
ACALEREM	0.75	4.38
CITRLINE	0.75	0.79
CANTVACC	0.67	3.33
DENHPARV	0.42	0.83
CITRSPIN	0.42	0.42

Subshrub /ground layer	Freq.
ANCIUNCI	0.93
SPARJUNC	0.93
SOLASTEL	0.87
ABUTOXAC	0.67
SOLACORI	0.53

Tree species	Freq.	M.Cov.
ERYTAUST	0.87	1.90
DIOSHUMI	0.80	2.77
CAPPARBO	0.80	2.37
BACKANGU	0.73	13.30
EHREMEMB	0.73	3.23
BURSINCA	0.73	2.13
ALECDIVE	0.67	1.63
BRACRUPE	0.60	4.47
MELIERYT	0.60	2.07
OWENVENO	0.53	5.30
ELATXYLO	0.53	1.53
BRIELEIC	0.53	1.43
CANTBRIG	0.53	1.27
ALSTCONS	0.53	0.27
DENHPITT	0.47	1.23
MAYTDISP	0.47	0.90
CANTBUXI	0.47	0.90
AUSTBIDW	0.47	0.87
MAYTBILO	0.47	0.73

Shrub species	Freq.	M.Cov.
BREYOBLO	0.42	0.21

Vines	Freq.
JASMSIAU	0.93
PARSLANC	0.80
SECAELLI	0.67
JASMDIRA	0.60
CISSOPAC	0.60
PASSAURA	0.47
TINOSMIL	0.40
CYNABOWM	0.40
PANDPAND	0.40
GYMNPLEI	0.40

Subshrub	Freq.
SOLASEMI	0.40
OLEACANE	0.40

Highest fidelity species (ie. >50% of records in group):
DENHPARV, BURSINCA, STIPRAMO

Group 5. Upper Dawson Valley (Injune/Taroom) [plots 9A, 10A, 10B, 15A, 15B, 16A, 16B, 17A, 17B, 18A, 33A, 36A, 37A, 37B, 49A, 49B, 50A, 50B, 51A, 51B, 52A, 52B, 57A, 57B, 58A, 63A, 63B]

This site-group is centred on the upper Dawson River catchment. It extends from west of Injune north to Bullaroo Creek, east to Taroom and north along the Expedition Range. Parent materials are predominantly fine-grained sediments (shales, claystones, etc.).

These vine thickets have a mixture of more inland species (e.g. *Apophyllum anomalum, Capparis loranthifolia, Geijera parviflora*) with elements of the subcoastal communities, e.g. *Excoecaria dallachyana, Elattostachys xylocarpa* and *Austromyrtus bidwillii*, especially in relatively moister situations such as footslopes and broad drainage lines.

The two species with highest fidelity in the group are *Alectryon pubescens* and *Cadellia pentastylis* (ooline). Those stands with *Cadellia pentastylis* form a distinct subgroup within the classification.

Summary structure:

Emergent layer: 15-20(-25)m
Canopy: 8-10(-15)m; 25-50(-60)%.
Tall shrubs/low trees: 4-8m; 40-50(-60)%
Low shrubs: 1-3(-5)m; 10-25(-50)%
Ground stratum: <1m; 5-10%

Mean plot area: 493 m^2 (292-861)

Mean altitude (339 (100-640)

Mean basal area:. 29.7 m^2/ha (9.3-77.4)

No. stems /ha: 1970 (835-2736)

Mean species counts: 11 (T) 7 (TS) 7 (LS) 5 (SS) 7(V)

Total: 37 (24-53)

Mean diversity (Shannon Index): 2.437 (1.887-3.003)

Evenness: 0.757 (0.653-0.867)

Frequent species:

Tree species	Freq.	M.Cov.
PLANCOPU	0.96	17.43
GEIJPARV	0.93	8.43
ALECDIVE	0.93	4.76
CAPPLORA	0.93	3.15
EHREMEMB	0.93	3.07
CROTINSU	0.89	15.37
NOTEMICR	0.85	3.57
DIOSHUMI	0.81	3.54
ACACFASC	0.74	5.63
CANTODOR	0.59	0.76
BRACRUPE	0.56	6.39
APOPANOM	0.56	1.09
CASSAUAN	0.48	2.13
DENHPITT	0.44	1.20
FLINCOLL	0.44	1.13
ERYTAUST	0.44	0.59
ALECCONN	0.44	0.59
CADEPENT	0.41	13.44
EXCODALL	0.41	6.59
ELATXYLO	0.41	0.94
OPUNTOME	0.41	0.46

Shrub species	Freq.	M.Cov.
CARIOVAT	1.00	21.28
CITRSPIN	0.93	3.09
DIPLIXOR	0.74	1.20
ACALEREM	0.63	2.30
CANTVACC	0.56	0.56
TURRPUBE	0.48	0.70
BREYOBLO	0.48	0.33

Vines	Freq.
CISSOPAC	0.89
SECAELLI	0.81
JASMDIRA	0.67
PARSLANC	0.63
JASMSIAU	0.48
PARSEUCA	0.48
CAPPLASI	0.48
CYNABOWM	0.44
TINOSMIL	0.41

Subshrub /ground layer	Freq.
ABUTOXAC	0.85
ANCIUNCI	0.81
SPARJUNC	0.78
SOLAPARV	0.67
SOLASEMI	0.52

High fidelity species (ie. >70% of records in group):

CADEPENT, ALECPUBE

Group 6. Nebo district [plots 31A, 44A, 44B, 45A, 45B, 47A, 47B]

This group of sites occurs on varying geological substrates: basalt (31), Cainozoic colluvium/alluvium (44) and intermediate and acid volcanics (45 and 47).

The main characteristic species for this group is *Terminalia oblongata*, a small-leaved, deciduous tree species which occurs widely in association with *Acacia harpophylla* in the central and northern Brigalow Belt region. The shrub *Grewia scabrella* and large deciduous tree *Lysiphyllum hookeri* are also characteristic of this site-group.

Summary structure:

Emergent/canopy layer: 10-15m; 20-25(-40)%
Subcanopy (tall shrubs/low trees): 4-8m; 20-30(-50)%
Low shrubs: 1-2(-4)m; 35-50(-70)%
Ground stratum: <1m; 1-5(-10)%

Mean plot area: 587 m^2 (294-905) **Mean altitude (m):** 295 (170-400)

Mean basal area:. 21.3 m^2/ha (15.7-29.5) **No. stems /ha:** 1574 (1223-2453)

Mean species counts: 10 (T) 8 (TS) 7 (LS) 2 (SS) 7 (V) **Total:** 34 (27-47)

Mean diversity (Shannon Index): 2.280 (1.957-2.826) **Evenness:** 0.708 (0.608-0.808)

Frequent species:

Tree species	Freq.	M.Cov.
PLANCOPU	1.00	17.64
LYSIHOOK	1.00	17.50
TERMOBLO	0.86	12.93
DIOSHUMI	0.86	8.07
CANTODOR	0.86	1.14
ALECCONN	0.86	1.14
ALECDIVE	0.71	3.43
NOTEMICR	0.71	2.07
GEIJSASA	0.71	2.07
BRACAUST	0.57	4.07
DENHOLEA	0.57	4.07
ERYTAUST	0.57	1.64
EHREMEMB	0.57	0.64
GYROAMER	0.43	1.93
STRYAXIL	0.43	1.57
DRYPDEPL	0.43	0.57
OPUNTOME	0.43	0.21
AUSTBIDW	0.43	0.21
EXOCLATI	0.43	0.21

Shrub species	Freq.	M.Cov.
ACALEREM	1.00	54.00
CITRSPIN	0.86	2.14
CARIOVAT	0.71	21.79
GREWSCAB	0.71	5.14
CROTPHEB	0.71	0.71
DIPLIXOR	0.71	0.36
EHREGRAH	0.57	0.29
ABUTMICR	0.43	3.64
FLUELEUC	0.43	0.93
BREYOBLO	0.43	0.21

Subshrub /ground layer	Freq.
ANCIUNCI	1.00

Vines	Freq.
PARSLANC	0.86
CISSOPAC	0.71
SECAELLI	0.71
TINOSMIL	0.57
GLOSHEMI	0.57
CAPPLASI	0.43
SOLASEAF	0.43
PARSPLAE	0.43

High fidelity species (ie. >70% of records in group):

TERMOBLO

Group 7. Mingela Bluff [plots 48A, 48B]

As discussed previously, placement of the two plots from this site with the other northern vine thickets (group 6) cannot be justified. In the bioregional analysis (see **Chapter 4**) this site is grouped with vine thickets in the Collinsville district (see **Figure 4.2**).

Summary structure:

Emergents: 10-12m; 5-10%
Canopy: 5-10m; 60-65%
Tall shrubs: 2-4m; 40-45%
Low shrubs: 1-2m; 5-10%
Ground: <1m; 5-10%

Major species:

Tree species	M.Cov.
MACRLEIO	65.00
LYSIHOOK	7.50
ACACFASC	3.00
GEIJSASA	1.75
BRACAUST	1.75

Shrub species	M.Cov.
GRAPEXCE	35.00
CARIOVAT	4.00
CROTARNH	1.75
RICILEDI	1.75
FLUELEUC	0.50
GREWSCAB	0.50

Group 8. Central Highlands [plots 7A, 7B, 8A, 8B, 11A, 11B, 12A, 12B, 13A,13B, 14A, 14B, 32A, 34A, 34B, 35A, 35B, 38A, 38B, 39A, 39B, 40A, 40B, 41A, 41B, 42A, 43A, 43B, 53A, 54A, 55A, 55B, 56A]

This group comprises the westernmost vine thicket stands, in the Springsure and Emerald districts, and other *Macropteranthes leichhardtii*-dominated stands eastward to the Bauhinia Downs/Moura district. Structurally the majority of the stands are open, dominated by the mostly multiple-stemmed *M. leichhardtii*. They are generally species-poor, the extreme being a stand with a single canopy species (plot 43A) (Bonnie Doon near Emerald).

Apart from *M. leichhardtii*, this group is characterised by *Ventilago viminalis*.

Parent materials in the eastern stands are predominantly sediments, but in the Springsure district, considerable areas of vine thicket occur on basaltic material There are probably too few samples to be able to detect clear structural or floristic differences in these stands which might be related to geological substrate. *Archidendropsis thozetiana* is present on basalt at upper Vandyke Creek and Mt Hope just north of Springsure, and was also recorded on Dilly Pinnacle.

Upper Vandyke Creek (site 56) represents the western limit of several species, including *Drypetes deplanchei, Flindersia australis* and *Melodorum leichhardtii*.

The major vine thicket remnants in nature conservation reserves (e.g. Carnarvon, Palmgrove National Parks) belong to this site-group, including the community at Dipperu National Park near Nebo, which is dominated by *Macropteranthes leiocaulis* rather than *M. leichhardtii*.

Summary structure:

Emergent layer: 15-20(-25)m; 5-10(-25)%
Canopy: 7-10(-12)m; 45-50(-70)%
Subcanopy (tall shrubs/low trees): 2-5(-8)m; 15-25(-50)%
Low shrubs: 1-2(-3)m; (10-)30-50(-75)%
Ground stratum: <1m; 5-10%

Mean plot area: 502 m^2 (335-943)   **Mean altitude (m):** 341 (160-580)

Mean basal area: 22.8 m^2/ha (9.9-51.8)   **No. stems /ha:** 2169 (1000-3881)

Mean species counts: 7 (T) 5 (TS) 5 (LS) 4 (SS) 5 (V)   **Total:** 26 (8-42)

Mean diversity (Shannon Index): 1.860 (0.179-2.531)   **Evenness:** 0.662 (0.163-0.796)

Frequent species:

Tree species	Freq.	M.Cov.
MACRLEIC	0.94	43.41
EHREMEMB	0.76	3.02
GEIJPARV	0.73	6.00
ALECDIVE	0.73	3.05
PLANCOPU	0.70	4.56
NOTEMICR	0.70	3.76
CROTINSU	0.67	8.91
CAPPLORA	0.61	1.56
BRACRUPE	0.55	4.50
DIOSHUMI	0.55	1.59
OPUNTOME	0.45	0.30
VENTVIMI	0.42	1.59

Shrub species	Freq.	M.Cov.
CITRSPIN	0.85	0.88
CARIOVAT	0.73	10.52
ACALEREM	0.58	23.53
DIPLIXOR	0.55	0.58
CANTVACC	0.52	2.85
CROTPHEB	0.42	2.82

Subshrub /ground layer	Freq.
SPARJUNC	0.85
SOLAPARV	0.81
ABUTOXAC	0.74
ANCIUNCI	0.56

Vines	Freq.
CISSOPAC	0.85
PARSLANC	0.70
SECAELLI	0.67
CAPPLASI	0.63
PARSEUCA	0.56
JASMDILI	0.44
TINOSMIL	0.41
JASMDIRA	0.41

High fidelity species (ie. >70% of records in group):
MACRLEIC, VENTVIMI, JASMDILI

3.8 Environmental factors and vine thicket community patterns

3.8.1 Soil parent material

Vine thicket communities in the study area occur on a wide range of soils and soil parent materials. They were recorded by Fensham (1995) on acid igneous rocks (granites and granodiorites); only one site in the present study (Mt O'Connell near Marlborough) was conclusively on this type of geological substrate (see **Appendix 4**). This vine thicket and its *Araucaria cunninghamii* emergents are presumably favoured by the large areas of outcropping rock which afford protection from fire and provide substantial runoff to augment rainfall.

Most other vine thicket sites occur on clay loam to medium clay soils, often with a relatively light-textured A horizon (duplex soils). They are derived predominantly from sediments, particularly claystones, mudstones, siltstones, shales and certain sandstones. There are also significant areas on basic and intermediate volcanics, particularly basalt, for example the Bunya Mountains foothills. No significant correlations could be detected between soil parent material and vine thicket species or community-types using either quantitative or binary data.

Relationships between vine thicket vegetation dominated by *Macropteranthes leichhardtii* and associated *Acacia harpophylla* communities and soil properties such as clay content and depth of A horizon are considered further in **Chapter 5**.

3.8.2 Climatic attributes

Correlations between plot biomass and diversity values and sixteen climatic attributes are shown in **Table 3.27**. Basal area and density are negatively correlated with rainfall seasonality, mean annual temperature and with mean temperatures of the warmest and wettest quarters and to a slightly lesser degree mean temperatures of the coldest and driest quarters. They are positively correlated with the mean rainfall of the driest period.

Plot diversity, measured as numbers of species and as the Shannon diversity index, is positively correlated with mean rainfall of the coldest and driest quarters and, to a lesser degree, mean annual rainfall. Diversity values are negatively correlated with maximum temperature of the warmest period and with mean temperatures of the warmest and wettest quarters.

When climatic data for the eight vine thicket site-groups were analysed, significant group effects ($P<0.001$) were detected for all 16 attributes. Means, medians and ranges of values of 10 attributes for each site-group are displayed in **Figure 3.17**.

There is a clear delineation between the ranges of attributes 2 and 5 (minimum and mean temperatures of the coolest month) for the northern and southern site-groups (Cramer values of 0.8405 and 0.8468 respectively) (the Cramer value is the between-group variance divided by the total variance and should only be used in a relative sense (Belbin 1991)). Of the summary rainfall data, attributes 10 (mean rainfall of the wettest month) and 13 and 16 (precipitation of the wettest/warmest quarters) also show this delineation.

Table 3.27 Spearman rank order correlation coefficients between biomass and diversity measures for vine thicket sites and 16 climatic (BIOCLIM 2.0) attributes.

Attribute	Basal area /ha	Trees /ha	No. of tree species	Tree + shrub species	Total species	Shannon diversity index
Annual Mean Temperature	-0.401^{***}	-0.295^{***}	-0.371^{***}	-0.266^{**}	-0.383^{***}	-0.298^{***}
Max Temperature of Warmest Period	-0.191^{*}	-0.293^{***}	-0.659^{***}	-0.731^{***}	-0.769^{***}	-0.701^{***}
Min Temperature of Coldest Period	-0.342^{***}	-0.182^{*}	-0.230^{**}	ns	ns	ns
Temperature Annual Range (2-3)	0.210^{*}	ns	-0.230^{**}	-0.407^{***}	-0.363^{***}	-0.319^{***}
Mean Temperature of Wettest Quarter	-0.409^{***}	-0.283^{***}	-0.563^{***}	-0.533^{***}	-0.634^{***}	-0.529^{***}
Mean Temperature of Driest Quarter	-0.374^{***}	-0.262^{**}	-0.303^{***}	-0.177^{*}	-0.271^{**}	-0.228^{**}
Mean Temperature of Warmest Quarter	-0.410^{***}	-0.303^{***}	-0.565^{***}	-0.533^{***}	-0.642^{***}	-0.540^{***}
Mean Temperature of Coldest Quarter	-0.359^{***}	-0.236^{**}	-0.267^{**}	ns	-0.235^{**}	-0.186^{*}
Annual Precipitation	ns	ns	0.431^{***}	0.524^{***}	0.558^{***}	0.453^{***}
Precipitation of Wettest Period	ns	ns	0.174^{*}	0.323^{***}	0.342^{***}	0.258^{**}
Precipitation of Driest Period	0.363^{***}	0.238^{**}	0.393^{***}	0.281^{***}	0.340^{***}	0.310^{***}
Precipitation Seasonality(C of V)	-0.320^{***}	-0.211^{*}	-0.309^{***}	ns	-0.180^{*}	-0.183^{*}
Precipitation of Wettest Quarter	ns	ns	0.169^{*}	0.317^{***}	0.307^{***}	0.243^{**}
Precipitation of Driest Quarter	0.344^{***}	0.246^{**}	0.530^{***}	0.434^{***}	0.489^{***}	0.450^{***}
Precipitation of Warmest Quarter	ns	ns	0.208^{*}	0.360^{***}	0.352^{***}	0.287^{**}
Precipitation of Coldest Quarter	0.236^{**}	ns	0.598^{***}	0.574^{***}	0.633^{***}	0.574^{***}
No. of records	**142**	**142**	**136**	**136**	**136**	**134**

*** P < 0.001, ** P >0.001, <0.01, * P >0.01, <0.05, ns (not significant) P >0.05.

Within the southern site-groups (1,4,5 and 8) there is an east/west gradient apparent in the data for attributes 6 and 8 (mean temperatures of the warmest/wettest quarter) (Cramer values of 0.8600 and 0.8570).

The significance of these trends is discussed further below (**Chapter 4**) in the context of an expanded set of climatic attributes and site-groups derived from analysis of data collected throughout the Brigalow Belt Biogeographic Region..

3.9 Discussion

The distribution of many dry rainforest species is highly patchy (Swaine *et al.* 1990, Dittus 1977). Dittus also noted a tendency for most species to have relatively small diameters and commented on species found within his study area which appeared only under special edaphic or biotic conditions. In the present study, several widespread dry rainforest species were recorded relatively infrequently - *Melaleuca bracteata*, for example, is found mostly along watercourses, and

Figure 3.17 Means, medians and ranges of values of 10 climatic attributes (BIOCLIM 2.0) for vine thicket site-groups based on classification (B-C/UPGMA clustering) of standardised cover data.

-Tables are groups (rows) by attributes values-
L=lower limit.....1=1st Quartile.....M=mean
D=Median.....3=3rd quartile.....U=upper limit
***=more than one symbol at print position**

Attribute: 1. Annual Mean Temp. Cramer value: 0.8480

```
    17.20          18.85          20.50          22.15      23.80
GRP +---------------+---------------+---------------+---------------+

1        L----1==D=M==3------U
2                          *
3                   L-------------------*=D=3--U
4   L---------1=====MD=====3-------U
5               L----------1====*==3---------U
6                                        *=*==*
7                                                  *
8                   L-----1=======MD====3----------U
```

.Attribute: 2. Max. Temp. Warmest Period Cramer value: 0.8405

```
    27.60          29.27          30.95          32.63      34.30
GRP +---------------+---------------+---------------+---------------+

1               L--1=========*=====3----U
2                          *
3                          L-1==DM====3-U
4   L---------------------------1=M====D====3U
5                                  L---1=====MD==3--U
6                                    L1*3U
7                                                  *
8                                      L----1==DM===3---U
```

Attribute: 3. Min Temp. Coldest Period Cramer value: 0.8641

```
    2.900          5.000          7.100          9.200      11.30
GRP +---------------+---------------+---------------+---------------+

1   L--1====*=====3-U
2                          *
3           L-------------------------------1==M=D========3-------U
4   L1=D===M===3------------U
5    L-----1==D==*-----------------------U
6                                        L1=DM=3-U
7                                                *
8    L----------1===D==M===3----------------------------U
```

Attribute: 4. Temp. Annual Range Cramer value: 0.8343

```
    19.50          22.02          24.55          27.07      29.60
GRP +---------------+---------------+---------------+---------------+

1                              L-----1===DM=====3----U
2                         *
3   L-------1===========M===D==3-------------------U
4                     L-----------------------1===M=====D==3-U
5                        L---------------------------*===D=3-U
6                L-1==*==3U
7                        *
8                    L-------------------------------1=M==D3-----U
```

Attribute: 5. Mean Temp. Coldest Quarter Cramer value: 0.8468

```
    22.00          23.30          24.60          25.90      27.20
GRP +---------------+---------------+---------------+---------------+

1           L----1======*=======3--U
2                          *
3                     L---------------1==M=D===3--U
4   L--------------------1====M==D=====3----U
5                          L----------1===MD====3--U
6                                  *==D=M=====3---U
7                                         *
8                                L---1======MD======3---U
```

Attribute: 6. Mean Temp. Warmest Quarter Cramer value: 0.8600

```
    12.90          14.88          16.85          18.83      20.80
GRP +---------------+---------------+---------------+---------------+

1 L---1====*==3-----U
2                         *
3             L--------------------1=*===3--U
4  L--1====*===3-------U
5  L---------1====DM=3-------------U
6                                 L1=D====M=====3--------U
7                                            *
8     L-----1=======*=====3----------------U
```

Attribute: 8. Mean Temp. Driest Quarter Cramer value: 0.8570

```
    11.60          13.45          15.30          17.15      19.00
GRP +---------------+---------------+---------------+---------------+

1  L---1====*====3-----U
2                         *
3              L-----------------------1=*====3---U
4 L--1=====DM==3-----------U
5  L---------1====DM==3---------------U
6                                   L1=*=*
7                                              *
8     L-----1========MD====3---------------------U
```

Attribute: 10. Rainfall Wettest Period Cramer value: 0.8435

```
    94.00          132.3          170.5          208.8      247.0
GRP +---------------+---------------+---------------+---------------+

1    L-1===*3-------------U
2                          *
3             L-----1==========DM======3-----------------------U
4  L-1=*=3U
5 L--1==DM=====3----U
6             L----1============DM==============3-------U
7                          *
8 L----1===*===3---U
```

Attribute: 12. Rainfall Seasonality (C of V) Cramer value: 0.9004

```
    44.00          57.25          70.50          83.75      97.00
GRP +---------------+---------------+---------------+---------------+

1   L--1==*=3-------U
2                       *
3               L---------1==D=M=3----------------U
4 L----1MD=3-U
5    L---1=D=M===3-----U
6                           L-1===MD=*
7                                         *
8   L-----------1=MD3----------------U
```

Attribute: 15. Rainfall Warmest Quarter Cramer value: 0 8130

```
    273.0          359.3          445.5          531.8      618.0
GRP +---------------+---------------+---------------+---------------+

1     L-1=DM=3--------U
2                          *
3              L-----1==========D=M======3-----------------------U
4   L-1=*==*
5 L----1====DM=====3---U
6           L----1============D=M==============3---------U
7      *
8 L---1=====MD==3---U
```

Melia azedarach, *Codonocarpus attenuatus* and *Duboisia leichhardtii* are generally confined to disturbed sites or the margins of vine thickets. This study was concerned primarily with identifying species patterns at the district or regional scale rather than within-stand variation. The sampling methodology therefore concentrated on areas considered relatively homogeneous in terms of structure and site characteristics, and deliberately avoided marginal situations, obvious canopy gaps and well-defined watercourses.

In attempting to identify floristic patterns within these communities, a range of data, both quantitative and binary, was collected and analysed using both classification and ordination procedures, which each emphasise different aspects of the data. The ordination process is complementary to classification in that it displays the similarity matrix and the relationships between the site-groups. In particular, it allows outliers within groups to be identified and checked for possible misclassification.

The results of the series of classifications undertaken in this study were broadly similar, with 3-4 coastal/subcoastal groups and 3-4 inland groups being identified (see **Figures 3.9** and **3.10**). Fensham (1995) (see above) also described north-south and east-west patterns in the northern inland vine thickets; his results are discussed further in relation to the bioregional classification (see **Chapter 4**).

Classifications were evaluated in terms of the agreement between subplots of the 56 sites with duplicate samples. Groups based on relative importance of the tree species were found to be unsatisfactory in comparison with those derived from standardised cover values. Basal area values vary considerably between subplots, reflecting the sporadic distribution of large individuals of *Brachychiton* spp. in particular, as well as the effects of localised disturbance. Much of the within-site variation was removed by excluding the data for *Brachychiton* spp. from these analyses.

A more satisfactory result was obtained when classifications were based on cover data of tree and shrub species. By considering the overall cover of each species, regardless of whether it is represented in the canopy (i.e. stems >10 cm dbh) or not, the classification is less influenced by locally favourable site factors or successional processes.

The inclusion of replicate plots in the classifications had several benefits. McKenzie *et al.* (1991) have noted the lack of a generally accepted method for determining the optimum number of groups from a dendrogram - this may be achieved by selecting the level of the hierarchy at which site-pairs remain in the same clusters.

An additional (and unexpected) result was the behaviour of site-pairs during the fusion (agglomerative) process (UPGMA). The majority of plots fused with their site-pair at an early stage of the process. For example, during the classification of standardised cover data, 37 site-pairs fused at the first level and a further 6 at the second level, leaving only 13 (of 56) site-pairs to fuse at higher levels of the classification. With the presence/absence data, 42 site-pairs fused at the first level and 7 at the second, leaving only 7 site-pairs to fuse at higher levels.

This process thus at least partially overcomes any inadequacies in terms of the number of species (from sites) recorded by individual plotless samples. As they fuse, the paired subplots are replaced by new, composite individuals (equivalent to the "sites"), and similarities for subsequent fusions are determined from their combined species totals.

There was relatively close agreement between distributions of the classificatory groups derived using species cover and presence-absence data (see section **3.6.1.2.1**). The classificatory hierarchies differed somewhat, with some re-arrangement of the major geographical groupings. For example, the Auburn (group 4) sites were closely linked with the upper Dawson Valley sites (group 5) on cover data, but when presence/absence data were used, they were placed with South-eastern Queensland and Central Queensland. The latter classification placed most Dawson Valley sites with the Central Highlands (*Macropteranthes leichhardtii*) sites.

The effects of exclusion of species recorded from single sites ("singletons") from the classifications depended on whether quantitative or binary data were being used. With quantitative data (relative importance or canopy cover), the removal of singletons did not affect the group compositions. These species were generally represented by single, small individuals which had little impact on overall basal area or cover of the sites. Removal of singletons from species presence/absence analyses, however, did improve agreement between site-pairs and group definition (see **3.6.1.2.1**).

In comparison with the agglomerative procedure, the divisive classificatory procedure TWINSPAN performed poorly both in terms of agreement between site-pairs and in overall definition of community-types (e.g. see **Figure 3.12**). The higher-level groups derived from

TWINSPAN do indicate geographical trends, however, with a primary division between coastal/subcoastal and more inland sites, and within the coastal communities, separation of northern and southern sites.

This study has identified 6 main floristic groups (community-types) within the vine thickets of central and southern Queensland. Groups 2 and 7 (of the preferred classification) represented single anomalous sites (22 and 48 respectively) which were shown by subsequent regional floristic analyses (Chapter 4) to be more appropriately placed in other, larger groups. Site 22 can be placed in the Central Queensland community-type (type 3), while site 48 (Mingela Bluff) is part of a group on mountainous sites in the Collinsville district and northward (i.e. outside the main study area).

The final 6 community-types may be considered as representing a broad *Brachychiton* spp. alliance (sensu Beadle 1981). There is little justification for attempting to recognise separate *Brachychiton australis* and *B. rupestris* suballiances as proposed by Beadle - *B. rupestris* occurred at or near 57 of the 75 sites, while *B. australis* co-occurred with *B. rupestris* at 28 sites distributed across most of the study area. *B. australis* was recorded alone at 10 vine thicket sites, predominantly in the Mackay - Rockhampton area.

Beadle (1981) placed *Macropteranthes leichhardtii* - dominated vine thickets (equivalent to community-type 8 of the present study) within a *Macropteranthes* spp. alliance. It is concluded that this community should be recognised as a *Macropteranthes leichhardtii* suballiance within the *Brachychiton* spp. alliance.

The other 5 community-types defined in this study could also be designated as suballiances, with diagnostic species nominated on the basis of frequency and mean % cover (see descriptions of community-types in section **3.7.1**).

Thus the following vine thcket suballiances may be recognised in central and southern Queensland:

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).

Beadle (1981) also recognised an ooline (*Cadellia pentastylis*) alliance, but in this study this species was found to occur as an emergent species in several vine thicket community-types, often in association with *Acacia harpophylla* (e.g. Injune-Rolleston, Mundubbera). It is most characteristically present as a dominant in relatively open communities which may have only minor vine thicket components.

Nix (1977) described 3 groups of vine thicket communities on differing substrates in the Fitzroy River region:

(i) vine thickets on relatively fresh rock material, principally Mesozoic shales and other labile sediments

(ii) those on deeply weathered basalt and secondary carbonates (typically dominated by *Macropteranthes leichhardtii*) and

(iii) vine thickets on deeply weathered sediments (often with emergent *Cadellia pentastylis*).

Nix's group (i) comprises community-types 1 and 4 from the present study, group (ii) is equivalent to community-type 8 and group (iii) approximates community-type 5.

In considering the possible influence of soil parent material in the present study, no significant differences could be detected between groups of sites on e.g. basic volcanics, fine-grained sediments and mixed volcanics and metasediments. This result was not unexpected, given the variability within some geological formations and the interaction between substrate, topographic position and climate in determining soil properties and vegetation type.

Apart from the results of studies by Johnson (1980, 1981) at Brigalow Research Station (see **Chapter 6**), there is little information available on structure or composition of vine thicket stands for comparison with the site data collected during the present study. Benson (1994) published data for a series of 20 m X 20 m plots in *Cadellia pentastylis* stands in northern New South Wales. Densities of *C. pentastylis* varied from 175-415/ha, compared with a range of 30-410/ha in the present study (all stems >3 m high). The largest diameter recorded by Benson was 124 cm (cf. 94 cm in the present study). Of the sample of 128 trees of *C. pentastylis* measured in this study, smaller stems (up to 30 cm dbh) made up 70% of the total.

Population structure was also examined in the 97 plots in which all stems >3m high had been counted. Apart from Cadellia pentastylis, 9 species had more than 70% of their stems in the >10 cm dbh category - *Brachychiton rupestris, B.australis, Lysiphyllum hookeri, Cupaniopsis parvifolia, Flindersia australis, Terminalia oblongata, Briedelia leichhardtii, Geijera salicifolia* var. *salicifolia* and *G. parviflora*. *Brachychiton rupestris* in particular had a very high proportion of large stems, with almost 70% (43/62) greater than 50 cm dbh.

Changes over time in population structure of an area of *Macropteranthes leichhardtii* - dominated vine thicket in central Queensland were the subject of a separate study (see **Chapter 7**).

The lower species-richness of inland vine thickets compared with those of subcoastal districts (see section **3.7**) and the tendency for one or a few species to dominate the canopy were also noted in the dry rainforests of Sri Lanka (Dittus 1977) and Puerto Rico (Murphy and Lugo 1986b).

In the more mesic vine thicket communities in south-eastern Queensland, however, diversities can be quite high (see **Table 3.15**). Comparisons with point-clump samples in other rainforest communities in south-eastern Queensland (Young and McDonald 1987, unpublished data) show that (canopy) species-richness in some thickets is similar to that of ANVF and AMVF and may exceed that of CNVF (see **Table 3.33**).

Apart from generally localised damage caused by cattle, most of the sites examined in this study were essentially undisturbed. There had been some selective cutting of trees at the Cracow (S06), Lake Nuga Nuga (S012) and Bracewell (S025) sites, but its impact has been minor compared with the mortalities caused in these communities by drought. Descriptions of analogous dry rainforest communities in Ghana and Puerto Rico (Swaine *et al.* 1990, Murphy and Lugo 1986b) are based on regenerating communities - the Shai Hills site (Ghana) is believed to have been farmed prior to 1892 and the Guanica Forest site was logged in the 1930s. The natural structure at the Shai

Table 3.28 Examples of numbers of species per 32 nearest-neighbour sample in south-eastern Queensland rainforests.

Location	Type	Species
1. Wonga Hills	SEVT	19
2. Peannga	SEVT	19
3. Nangur	SEVT	18
4. Windera	SEVT	18
5. Berlin Scrub	SEVT	17
6. Jimna	ANVF	15-18
7. Enoggera S.F.	ANVF/AMVF	15-18
8. Woowonga Range	ANVF/AMVF	16-18
9. Mt Glorious	NVF	6-15
10. Mt Glorious	CNVF	13-17
11. Conondale Range	NVF/CNVF	12-15

Hills site has been modified in terms of the multiple stems of *Diospyros* spp., which coppice freely after cutting, but rarely produce basal sprouts otherwise (Swaine *et al.* 1990).

The vine thickets of the study area appear in general to have a more complex structure compared with the Guanica and Shai Hills forests. The Guanica Forest ranges in height from 5 m to 9 m and there do not appear to be the large emergents so characteristic of the Australian vine thickets. The Shai Hills forest is taller, with an average canopy height of c. 11 m, and occasional large emergents up to 30 m high (*Ceiba pentandra*), which is similar to the general structure of vine thickets in much of the study area. Swaine *et al.* noted that only the large emergents were deciduous and that other species generally remained small, even under more favourable climatic conditions. Inthe subtropical Australian vine thickets, most of the larger trees are deciduous or semi-deciduous (see section **3.5.2**) and relatively few other species reach diameters of 50 cm or greater (see **Table 3.11, Appendix 7**).

There was little evidence of fire within most vine thicket sites visted during this study. Fensham (1995) noted that except for the Forty Mile Scrub and communities on deep sands near Charters Towers, vine thicket occurrences in northern inland Queensland are mostly protected from fire by their topographic situations. In the southern section of his study area, however, there were originally large areas of vine thicket which lacked topographic protection. These occurred mostly on relatively deep soils and have now been largely cleared.

Extensive areas of vine thicket in the Central Highlands also occupy middle to lower slopes on a range of landforms. In their undisturbed state they are generally buffered against fire by the

Clearing of the adjacent footslopes and establishment of dense pastures of *Cenchrus ciliaris* and *Panicum maximum* var. *trichoglume* have exposed many vine thicket remnants to frequent severe fires which cause the death of vine thicket canopy species and facilitate invasion by *C. ciliaris* and other adventive species. Repeated fires coupled with the slow rates of regeneration in these communities are causing rapid attrition of roadside remnants and many hillslope fragments.

The primary aim of the present study was to determine whether there are definable floristic patterns within the vine thickets of central and southern Queensland. Six site-groups (community-types) have been defined using both quantitative and non-quantitative (presence/absence data). These are considered each to represent a floristic suballiance, together forming a vine thicket alliance which corresponds to the *Brachychiton* spp. alliance described by Beadle (1981). The recognition of distinct *Brachychiton rupestris* and *B. australis* suballiances by Beadle is considered unwarranted and communities dominated by *Macropteranthes leichhardtii* are recognised as forming a suballiance of the *Brachychiton* alliance rather than a separate alliance.

A secondary aim of this study was determine whether there are correlations between community patterns and diversity and climatic factors. Most of the community-types are significantly different in terms of a range of climatic attributes, and diversity has been shown to decrease with lower, more seasonal rainfall regimes.