Plate 11. Vine thicket remnant, "Stuart Downs", Wandoan (type 5). Species include *Acacia fasciculifera*, *Geijera parviflora*, *Ehretia membranifolia*, *Flindersia collina* and *Planchonella cotinifolia* var. *pubescens*.

Plate 12. Cleared vine thicket (type 6), Nebo district. Note effects of recurrent fires on hillslopes.

CHAPTER SIX

TEMPORAL PATTERNS IN VINE THICKET COMMUNITIES WITH PARTICULAR REFERENCE TO CHANGES RECORDED OVER 20-25 YEARS IN A *MACROPTERANTHES LEICHHARDTII* STAND AND ASSOCIATED VINE THICKET VEGETATION IN CENTRAL QUEENSLAND

There have been few long-term studies in Australian rainforests, and certainly none to compare in duration with the study of regeneration of arid zone rangeland at Koonamore Vegetation Reserve in South Australia, which was established in 1926 (Hall, Specht and Eardley 1964). Several have been undertaken in the moister tropical and subtropical rainforests, generally aimed primarily at monitoring the effects of logging and other forest management practices on productivity of the major commercial species. Much of this research was initiated by the Queensland Forest Service in the Wet Tropics of north-eastern Queensland (Nicholson, Henry and Rudder 1988). Webb, Tracey and Williams (1972) studied regeneration in an area of subtropical rainforest at Mt Glorious which was felled in 1957 and in north-eastern New South Wales the effects of logging of rainforest have been monitored on the Tweed Range (Horne and Gwalter 1982) and in the Hastings Valley (King and Chapman 1983).

The Queensland Forest Service also maintains several yield plots in undisturbed rainforest (i.e. not subject to logging and silvicultural treatment) in north-eastern Queensland (Nicholson *et al.* 1988). One of the longest-established of these (1952) is a 0.4 ha plot on the Lamb Range (Davies Creek), which also forms part of a more intensive study of rainforest dynamics initiated by Connell in 1963 in the Wet Tropics (i.e. Davies Creek) (1.68 ha) and in subtropical rainforest in Lamington National Park (1.98 ha) (Connell, Webb and Tracey 1984). In 1971 a series of 0.5 ha plots was established in unlogged rainforest at 19 locations in north-eastern Queensland between Iron Range and Eungella (West, Stocker and Unwin 1988).

Overseas studies of dynamics in dry seasonal forest have been of relatively short duration, with Shai Hills (Ghana) established in 1976 (Swaine *et al.* 1990) and Guanica (Puerto Rico) in 1981 (Murphy and Lugo 1986b).

An alternative approach to the study of temporal patterns involves the comparison of data from plots in patches of vegetation with differing time periods since disturbance (e.g.. clearing or selective logging). This approach has been applied in Trinidad (Greig-Smith 1952) and in Nigeria (Ross 1954) and was adopted by Hopkins (1975) in his study of secondary succession in subtropical rainforest at Green Mountains, Lamington National Park. The validity of this approach depends upon each plot/patch having similar environmental attributes (particularly soils and aspect) and assumes (in the absence of written or oral records) that each plot/patch had similar composition (dominants, etc.) prior to disturbance and that the treatments were similar in terms of procedures and timing, i.e. the season in which they occurred.

A similar approach was considered at the commencement of the present study, and it was planned to use the field survey (**Chapter 3**) to locate areas of regenerating vine thicket and to compare areas of known history, in reasonably close proximity on the same landform. This approach was not possible however - most clearing of vine thicket communities has occurred in relatively recent times and areas which may have represented older regrowth were not readily apparent either from aerial photointerpretation or from the field surveys. In recent years the establishment of dense pastures of *Cenchrus ciliaris* and subsequent firing (often annually) (as a deliberate means of controlling woody regrowth) has meant that regrowth communities of the susceptible vine thicket species are virtually non-existent.

These burning regimes are also adversely affecting the adjacent margins of many remnant areas of vine thicket, including those which have been set aside for nature conservation purposes, e.g. the "Welcome" section of Carnarvon National Park. Melzer (pers comm. 1995) has established monitoring plots in an area of *Macropteranthes leichhardtii*-dominated vine thicket in the Ka Ka Mundi section of Carnarvon National Park burnt in 1990. Results from re-measurements of these plots in May 1993 are included in the discussion below.

Johnson (1981) has reported the results of studies in cleared and regenerating *Acacia harpophylla* woodland on Brigalow Research Station. After these plots were established (1963), others (1965 and 1966) were placed in cleared *Macropteranthes leichhardtii*-dominated vine thicket. Unfortunately these latter plots were abandoned 3-4 years after establishment (Johnson pers comm.

1995), but the results are of value in indicating those species which regenerate readily from rootstock.

Studies of succession in moist tropical and subtropical rainforests have established the existence of two main groups (guilds) of rainforest tree species, based on their regeneration characteristics (Swaine and Whitmore 1988); (i) relatively fast-growing, short-lived, light-demanding species (pioneers) and (ii) slower-growing, longer-lived and shade-tolerant species (non-pioneer or climax species) The first group includes the early secondary (Group B) and the latter the late secondary (Group C) and mature phase (Group D) species of Hopkins *et al.* (1977).

They can also be grouped/classified in terms of individual life-history ("vital") attributes (Noble and Slatyer 1980), e.g. root resprouters and seed regenerators. There is evidence (Murphy and Lugo 1987a) that vegetative regrowth is a major component of regeneration in dry seasonal forests. Moreover, soil seed banks in these forests appear to be deficient in rapidly-growing (pioneer) tree and shrub species when compared with those of moister forests (e.g. Hopkins *et al.* 1990).

Russell-Smith and Dunlop (1987) summarised information on modes of regeneration and fruit dispersal for northern Australian vine thicket species, but little has been published on the eastern Australian species. Much potentially useful data has been gathered however by field naturalists and native plant enthusiasts. Because of the significant role played by frugivorous birds in dispersal of species in the moister subtropical rainforests (Innis 1989), the lists of bird species available for many vine thicket locations are also a valuable resource. Russell-Smith and Lee (1992) have drawn attention to the small population sizes of many monsoon forest plant species and the significance of animal vectors in genetic interchange between patches.

The permanent transect established by Johnson (1980) at Brigalow Research Station (see **Chapter 5**) provides a unique opportunity to explore changes over time (25 years - 1967-92) within a vine thicket community and associated *Acacia harpophylla*-dominated vegetation. **The present study seeks to determine changes in species abundance and population structure within each community and across their interface. It also seeks, through re-location of individuals of the major tree species, to determine rates of growth over this 25-year period. The results are then interpreted in relation to current successional theory and knowledge of life-history attributes compiled from published and unpublished sources.**

6.1 Methods

Data were collected from three sources;

6.1.1 Re-measurement of Brigalow Research Station transect plots

A subset of 16 20 m X 20 m plots (12-14, 18-21, 30, 37-40 and 58-61) (see **Figure 5.1**) was re-measured, following the procedure of Johnson (1980), as outlined in **Chapter 5**. Every tenth plot along the 3.7 km transect was re-measured in February 1990 and this preliminary sample (i.e. 18 plots) included plots 20, 30, 40 and 60. An additional 12 vine thicket plots were re-measured in October 1992 .

For comparisons between vegetation types, individual sites and the two sampling periods (i.e. 1968-70 and 1990-92), stem measurements were simplified to ten diameter classes:

1	<2.5 cm dbh (≥30 cm high)
2	2.5-4.9 cm dbh
3	5.0-9.9 cm
4	10.0-19.9 cm
5	20.0-29.9 cm
6	30.0-39.9 cm
7	40.0-49.9 cm
8	50.0-74.9 cm
9	75.0-99.9 cm
10	≥100 cm.

6.1.2 Recording of supplementary growth data for vine thicket tree species

Individual trees were located and re-measured elsewhere along the Brigalow Research Station transect. It was extremely difficult to single out individuals of the dominant *Macropteranthes leichhardtii*, but several of the less frequent species could be relocated confidently from the original plot data sheets. These included *Acacia fasciculifera, Atalaya salicifolia,* *Brachychiton rupestris, Flindersia collina* and *Geijera parviflora.* Height and diameter at breast height data were recorded for 20 species altogether.

No growth data were available from other vine thicket communities, but limited comparisons can be made with 11 years' data from tagged trees and shrubs in two 20 m X 20 m plots in araucarian vine forest at Yarraman in south-eastern Queensland. Annual rainfall (818 mm) is appreciably higher than that for Brigalow Research Station (see **5.1.1**), but severe drought conditions had prevailed in this area for several years prior to re-measurement of the plots in January 1995.

6.1.3 Collation of information relating to modes of regeneration and dispersal of vine thicket tree species

Data for 79 subtropical vine thicket species were collated from the literature (Floyd 1989), from field notes made during the detailed survey (**Chapter 3**), and observations on growth, fruit-types, animal vectors, etc. supplied by various colleagues (see **Appendices 7, 8**). Lists of frugivorous birds for the more eastern vine thickets were extracted from Horsup, James and Porter (1994).

6.2 Seasonal trends

Seasonal conditions in the months preceding the re-measurement of the transect plots (see above) had been relatively dry and the ground stratum was particularly sparse on both occasions. Grazing pressure by macropods (black-striped and/or swamp wallabies) appeared to be particularly heavy in most parts of the transect, and many small trees and shrubs had been browsed.

Rainfall trends at Brigalow Research Station over the period 1966-1990 are shown in **Table 6.1**. Each month's total is shown as a proportion of the median value for that month, e.g. 0.89 indicates a monthly total 89% of the median value.

As noted in **Chapter 5 (Tables 5.1, 5.2)**, the median value for the 25 year period is very close to the long-term median rainfall for nearby locations such as "Bauhinia Downs" and "Coorada".

Table 6.1 Monthly rainfall at Brigalow Research Station (1966-1990), expressed as proportions of (monthly) median values*

	Jan.	Feb.	Mar.	Apr	May	Jun.	July	Aug.	Sep.	Oct	Nov.	Dec.	Total (mm)
1966	0.51	0.79	2.38	0.00	0.38	2.68	1.00	3.72	0.98	0.99	0.79	0.83	610
1967	2.43	0.45	0.92	0.48	0.37	3.88	0.01	1.30	0.00	1.53	0.23	1.00	592
1968	1.85	1.38	1.72	6.46	1.24	0.00	1.69	1.20	1.59	0.07	0.27	1.23	741
1969	0.44	0.93	1.55	0.39	1.17	0.90	0.18	0.37	0.34	2.08	1.00	0.98	540
1970	2.06	0.46	0.53	0.66	0.00	0.97	0.01	0.40	1.87	0.79	0.90	1.81	561
1971	1.92	3.76	0.07	0.91	0.47	0.08	0.26	3.14	0.98	1.19	0.41	1.33	807
1972	1.48	1.67	0.33	0.68	0.95	1.71	0.00	0.12	0.64	1.78	1.25	0.64	613
1973	1.82	1.26	0.72	0.11	0.46	1.75	3.64	1.35	2.57	0.86	1.82	2.78	959
1974	2.09	0.74	0.22	4.07	0.63	0.13	0.64	2.55	5.09	1.05	1.39	0.97	773
1975	0.96	1.11	1.00	1.27	0.00	1.30	1.27	1.58	1.07	2.14	0.81	4.20	901
1976	1.39	0.53	1.35	0.90	1.27	0.86	0.98	0.37	2.45	0.72	1.45	1.13	626
1977	0.80	0.94	2.26	0.00	2.85	0.39	0.16	0.08	0.00	0.16	1.83	0.13	511
1978	3.03	1.76	0.33	3.17	1.35	3.50	3.16	2.50	5.91	0.39	2.10	0.83	1127
1979	0.29	1.59	0.66	1.02	0.51	1.93	0.03	0.60	0.06	0.94	1.10	1.08	503
1980	2.35	2.73	2.70	0.08	1.02	0.23	1.01	0.51	0.00	1.00	0.11	0.59	709
1981	0.62	2.23	1.14	4.85	1.80	1.83	1.34	0.45	0.01	0.65	1.95	0.64	774
1982	0.98	1.01	1.54	0.91	0.82	0.00	0.23	0.35	1.15	0.70	0.08	1.01	432
1983	0.98	0.67	1.37	11.94	6.82	1.65	1.98	1.17	0.25	1.56	1.80	0.51	1110
1984	1.51	0.19	2.17	1.40	0.33	0.77	5.38	0.77	8.29	2.16	0.18	1.46	904
1985	0.62	1.46	0.73	1.19	1.01	2.44	1.40	1.71	1.38	1.61	0.59	1.69	711
1986	0.84	1.07	0.15	0.25	1.98	0.58	1.00	0.99	2.24	4.08	2.41	0.50	816
1987	1.58	0.57	0.40	1.33	1.79	1.00	1.68	0.35	0.60	1.47	1.60	0.76	645
1988	0.77	0.63	1.00	4.43	0.67	1.18	2.02	6.79	0.70	0.20	0.56	3.55	906
1989	1.01	1.71	3.44	6.74	1.39	0.52	1.65	1.38	1.73	1.08	1.72	0.51	910
1990	0.12	0.68	2.23	7.66	1.67	1.34	0.02	0.00	0.28	0.78	0.22	2.04	641
1966/90 (median)	75.4	79.4	39	19.4	41.4	23	32.1	25.7	19.6	57	74.7	85.6	708

***e.g. the figure of 0.51 for January 1966 indicates a monthly total 51% of the median value for that month of 75.4 mm, i.e. 38.5 mm.**

6.3 Results from re-measurement of Brigalow transect plots

6.3.1 General trends across vegetation groups

(a) Canopy and understorey trees

Comparison of the number of species of trees and shrubs exceeding 2.5 cm diameter at breast height in the 20 m X 20 m plots at the first and second sampling showed a significant increase during the period. The average number of species per plot increased from 11.5 to 14 species ($p<0.001$). Only one species, *Croton phebalioides*, was lost but five species - *Citriobatus spinescens, Capparis* *mitchellii, Notelaea microcarpa, Cassine australis* var. *angustifolia* and *Canthium odoratum* - were recruited into these size classes.

The number of individuals in these size classes also increased significantly during the period ($p<0.05$). Most species increased in density. Marked decreases were recorded for *Acacia harpophylla* (n.s.), *Casuarina cristata* (n.s.), *Croton phebalioides* (n.s.) and *Opuntia tomentosa* ($p<0.05$), while significant increases occurred with *Acacia fasciculifera* ($p<0.05$), *Canthium* sp. "brigalow" ($p<0.05$), *C. vacciniifolium* ($p<0.05$), *Citriobatus spinescens* ($p<0.001$), *Croton insularis* ($p<0.01$) and *Ehretia membranifolia* ($p<0.01$).

There was a slight increase in cumulative canopy cover but it was not significant. A few species - *Citriobatus spinescens* ($p<0.05$), *Croton insularis* ($p<0.05$) and *Ehretia membranifolia* ($p<0.01$) - showed significant increases.

A comparison of the total basal areas of trees and shrubs exceeding 2.5 cm diameter at breast height showed a significant increase over the period ($p<0.05$). Most species increased their basal area but substantial decreases occurred with *Acacia harpophylla* ($p<0.05$). Significant increases were recorded for *Citriobatus spinescens* ($p<0.05$), *Canthium vacciniifolium* ($p<0.05$), *Ehretia membranifolia* ($p<0.001$), *Geijera parviflora* ($p<0.05$), *Diospyros humilis* ($p<0.05$), *Macropteranthes leichhardtii* ($p<0.01$) and *Brachychiton rupestris* ($p<0.05$).

Each plot was subdivided into four quarters and presence in one or more quarters allowed a measure of frequency which indicated shifts in spatial cover. There was a significant increase in total frequency during the period ($p<0.01$), indicating there was increased dispersion of individuals. Marked decreases occurred with a few species - *Acacia harpophylla* (n.s.) and *Opuntia tomentosa* ($p<0.01$) - but significant increases were recorded for *Acacia fasciculifera* ($p<0.05$), *Canthium* sp. "brigalow" ($p<0.05$), *Canthium vacciniifolium* ($p<0.05$), *Citriobatus spinescens* ($p<0.01$), *Croton insularis* ($p<0.01$) and *Ehretia membranifolia* ($p<0.05$).

(b) Shrubs

Comparisons were also made in the composition and structure of the woody understorey stratum. These included all trees and shrubs less than 2.5 cm diameter at breast height and more than

30 cm in height (i.e. stem class 1). Unlike the upper stratum, there was a significant decrease in the average number of species per plot from 11.4 to 9.3 ($p<0.05$). Six species (*Breynia oblongifolia, Cassia tomentella, Denhamia pittosporoides, Eremocitrus glauca, Erythroxylum australe* and *Ficus opposita*) were recorded for the first time in the second sampling while two species were lost (*Myoporum deserti* and *Planchonella cotinifolia* var. *pubescens*).

The density of the understorey species also decreased significantly during the period ($p<0.01$). Significant reductions were recorded for *Carissa ovata* ($p<0.05$), *Ehretia membranifolia* ($p<0.05$), *Diospyros humilis* ($p<0.01$), *Opuntia tomentosa* ($p<0.01$) and *Spartothamnella juncea* ($p<0.01$).

No significant changes were recorded in total canopy cover of any of the individual species.

The total frequency of the individual understorey species decreased significantly during the period ($p<0.01$). Significant declines in frequency were recorded for *Ehretia membranifolia* ($p<0.01$), *Opuntia tomentosa* ($p<0.001$) and *Spartothamnella juncea* ($p<0.01$).

(c) Subshrubs and herbaceous species

Only limited data are available from quadrat measurements along the centre line of the transect. The ground layer was generally very sparse, probably a reflection of both the continuing poor seasonal conditions and the heavy grazing pressure from the large numbers of wallabies using the transect for shelter (see below). The ephemeral fern *Cheilanthes distans* was recorded only once in the 17 plots re-measured in 1990-92, whereas more than 1100 plants were counted when the plots were established.

Numbers of the subshrubs *Abutilon oxycarpum* and *Phyllanthus maderaspatensis* were also much lower (from 91 and 15 respectively to 5 and 4 on re-measurement). Due to overall low counts, few of the larger shrub and tree species showed definite trends, but numbers of juveniles of *Croton insularis* and *Opuntia tomentosa* were very much reduced in the re-measured plots (27/2 and 17/0 respectively).

6.3.2 Changes within different vegetation groups

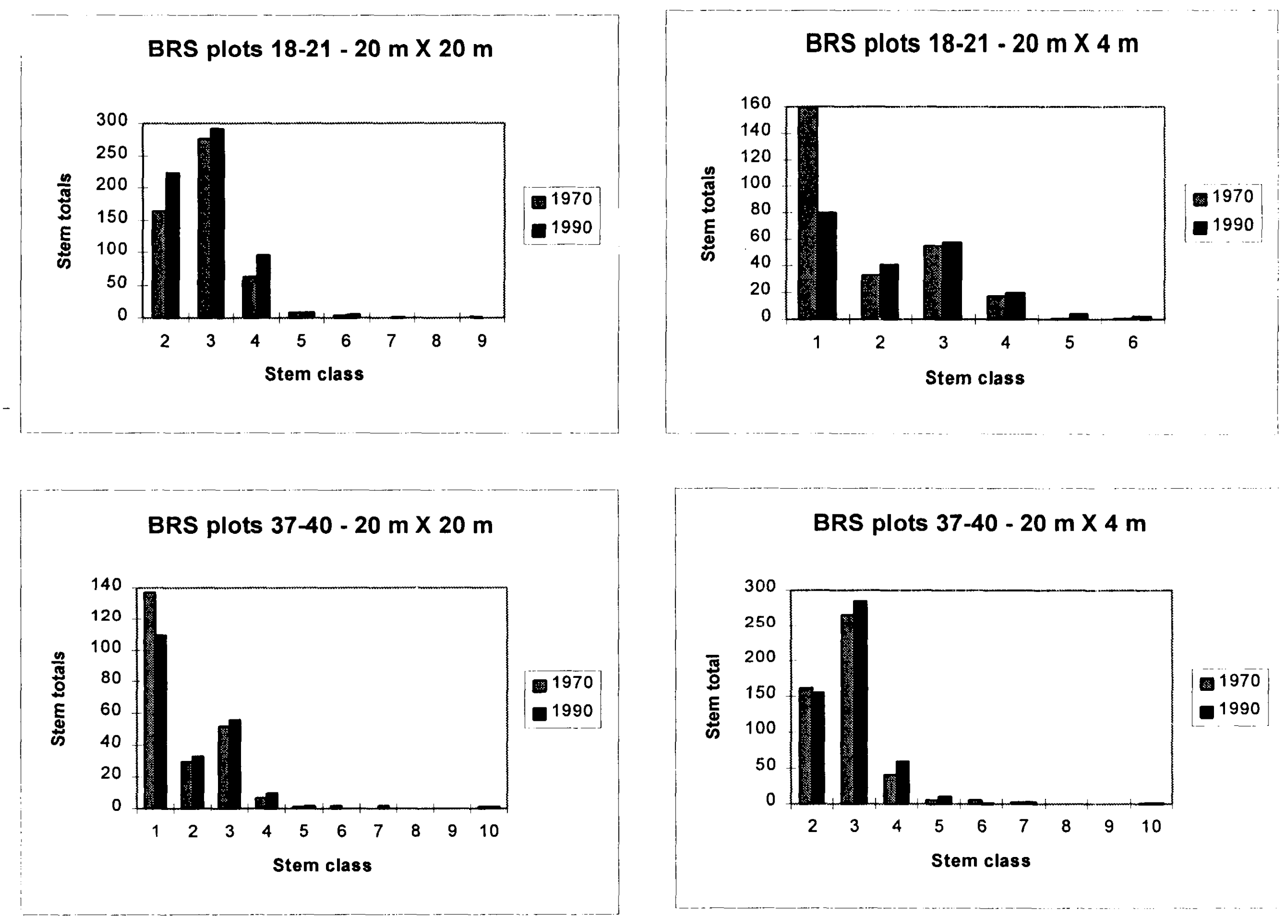
Comparisons were made between pooled data for plots 18-21 (group 6 - bonewood-dominant vine thicket) and plots 37-40 (group 5 - brigalow/bonewood).

(i) All species

Figure 6.1 illustrates the proportions of stems in the ten size classes and compares the 1968-70 and 1990-92 measurements.

The total numbers of trees and shrubs in the 20 m X 20 m plots (i.e. size classes 2 and greater, >2.5 cm dbh) increased significantly between 1968-70 and 1990-92 for both groups of plots (518-624 and 482-519 for groups 6 and 5 respectively).

Figure 6.1 Comparison of total stem counts in Brigalow RS transect plots 18-21 (group 6) and 37-40 (group 5) measured in 1968-70 and 1990-92.



Whilst this trend was also reflected in the 20 m X 4 m subplots for groups 6 and 5 (107-125 and 93-104 respectively for size classes 2 and larger), inclusion of size class 1 (stems >30 cm high but <2.5 cm dbh) resulted in an overall decrease in stem numbers. The decrease in the low shrub layer over this period was most marked in the group 6 plots (80 in 1990-92 compared with 159 in 1968-70). The corresponding decrease in the group 5 plots was from 137 to 109.

A small proportion of these stems had obviously grown into larger size classes, with overall increases in size classes 2, 3 and 4 for group 6 and classes 3, 4 and 5 for group 5. Total numbers of stems in the larger size classes (5-9) did not change in either group between 1968-70 and 1990-92.

(ii) Individual species

Numbers of species recorded in the 20 m X 20 m plots increased for both groups 6 (bonewood) and 5 (brigalow/bonewood) (17/20 and 13/20 respectively), whereas in the 20 m X 4 m subplots numbers decreased slightly for group 6 and did not change in group 5.

Several species showed little change in total number of stems between the two measurements, with individual stems moving into larger size classes (e.g. *Acacia harpophylla, Diospyros humilis, Flindersia collina, Casuarina cristata*). Those species with significant changes in stem numbers included *Acacia fasciculifera* (group 6), *Atalaya salicifolia* (6), *Canthium vacciniifolium* (5,6), *Croton insularis* (5,6), *Ehretia membranifolia* (5,6), *Geijera parviflora* (5), *Macropteranthes leichhardtii* (5,6) and *Opuntia tomentosa* (5,6) (see **Tables 6.2, 6.3** and **Figures 6.2, 6.3**).

In the group 6 (bonewood) plots, *Acacia fasciculifera* showed a major increase in stem numbers (5-13) between 1968-70 and 1990-92. Data from the 20 m X 4 m subplots indicates this recruitment to have been present as class 1 stems in 1968-70. A similar trend was shown by *Atalaya salicifolia*, although it differed slightly in that numbers of smaller (class 1) stems did not decrease at the second measurement.

Both *Canthium vacciniifolium* and *Croton insularis* showed large increases in stem numbers in the group 6 20 m X 20 m plots (33-78 and 31-87 respectively). As for *Acacia fasciculifera* (see above), this increase appears to have been derived from the large numbers of class 1 stems recorded in 1968-70, but recruitment into this latter class has not been sustained.

In the group 5 (brigalow-bonewood) plots, there were also increases in numbers of *C. vacciniifolium* and *C. insularis,* although the density of the former species remained very much lower than in group 6. In contrast to the group 6 results however, the numbers of size class 1 stems were much greater in 1990-92 than in 1968-70.

Table 6.2 Comparison of numbers and sizes of stems of seven vine thicket species in BRS transect plots 18-21 (group 6) measured in 1968/70 and in 1990/92.

		Size Class (20 m x 20 m)									Size Class (20 m x 4 m)						
Species	Year	2	3	4	5	6	7	8	9	Total	1	2	3	4	5	6	Total
ACACFASC	1970	0	0	0	1	3	0	0	1	**5**	4	0	0	0	0	1	**5**
	1990	4	4	2	0	3	0	0	0	**13**	1	1	1	0	0	1	**4**
ATALSALI	1970	0	1	5	1	0	0	0	0	7	6	0	0	4	0	0	**10**
	1990	5	2	3	2	0	0	0	0	**12**	7	1	0	2	2	0	**12**
CANTVACC	1970	23	9	1	0	0	0	0	0	**33**	30	4	3	0	0	0	**37**
	1990	63	14	0	0	0	0	0	0	**78**	14	12	3	0	0	0	**29**
CROTINSU	1970	15	14	2	0	0	0	0	0	**31**	31	2	3	0	0	0	**36**
	1990	53	28	3	0	0	0	0	0	**87**	12	8	6	0	0	0	**26**
EHREMEMB	1970	3	1	8	0	0	0	0	0	**12**	4	1	0	2	0	0	7
	1990	2	5	6	2	0	0	0	0	**15**	2	0	2	0	1	0	**5**
MACRLEIC*	1970										74	23	48	8	0	0	**153**
	1990										38	17	46	14	0	0	**115**
OPUNTOME	1970	2	1	1	0	0	0	0	0	**4**	4	0	1	1	0	0	**6**
	1990	0	0	3	1	0	0	0	0	**4**	1	0	0	2	1	0	**4**

Table 6.3 Comparison of numbers and sizes of stems of six vine thicket species in BRS transect plots 37-40 (group 5) measured in 1968/70 and in 1990/92.

		Size Class (20 m x 20 m)						**Size Class (20 m x 4 m)**					
Species	**Year**	**2**	**3**	**4**	**5**	**Total**	**Year**	**1**	**2**	**3**	**4**	**5**	**Total**
CANTVACC	1970	1	0	0	0	**1**	1970	5	0	0	0	0	**5**
	1990	5	1	0	0	**6**	1990	15	1	0	0	0	**16**
CROTINSU	1970	8	3	0	0	**11**	1970	6	1	1	0	0	**8**
	1990	29	13	1	0	**47**	1990	17	5	4	0	0	**26**
EHREMEMB	1970	9	9	6	0	**24**	1970	13	2	0	1	0	**16**
	1990	12	14	5	1	**32**	1990	3	3	2	1	0	**9**
GEIJPARV	1970	0	0	1	1	**2**	1970	1	0	0	0	1	**2**
	1990	1	2	1	1	**5**	1990	4	0	0	0	1	**5**
MACRLEIC*	1970						1970	58	23	48	4	0	**133**
	1990						1990	43	17	46	8	0	**114**
OPUNTOME	1970	10	5	2	0	**17**	1970	22	2	1	0	0	**25**
	1990	0	0	2	1	**3**	1990	0	0	0	0	0	**0**

* *Macropteranthes leichhardtii* was measured and counted only in the 20 m x 4 m subplots.

Figure 6.2 Comparison of stem counts in Brigalow RS plots 18-21 (group 6) measured in 1968-70 and in 1990-92.

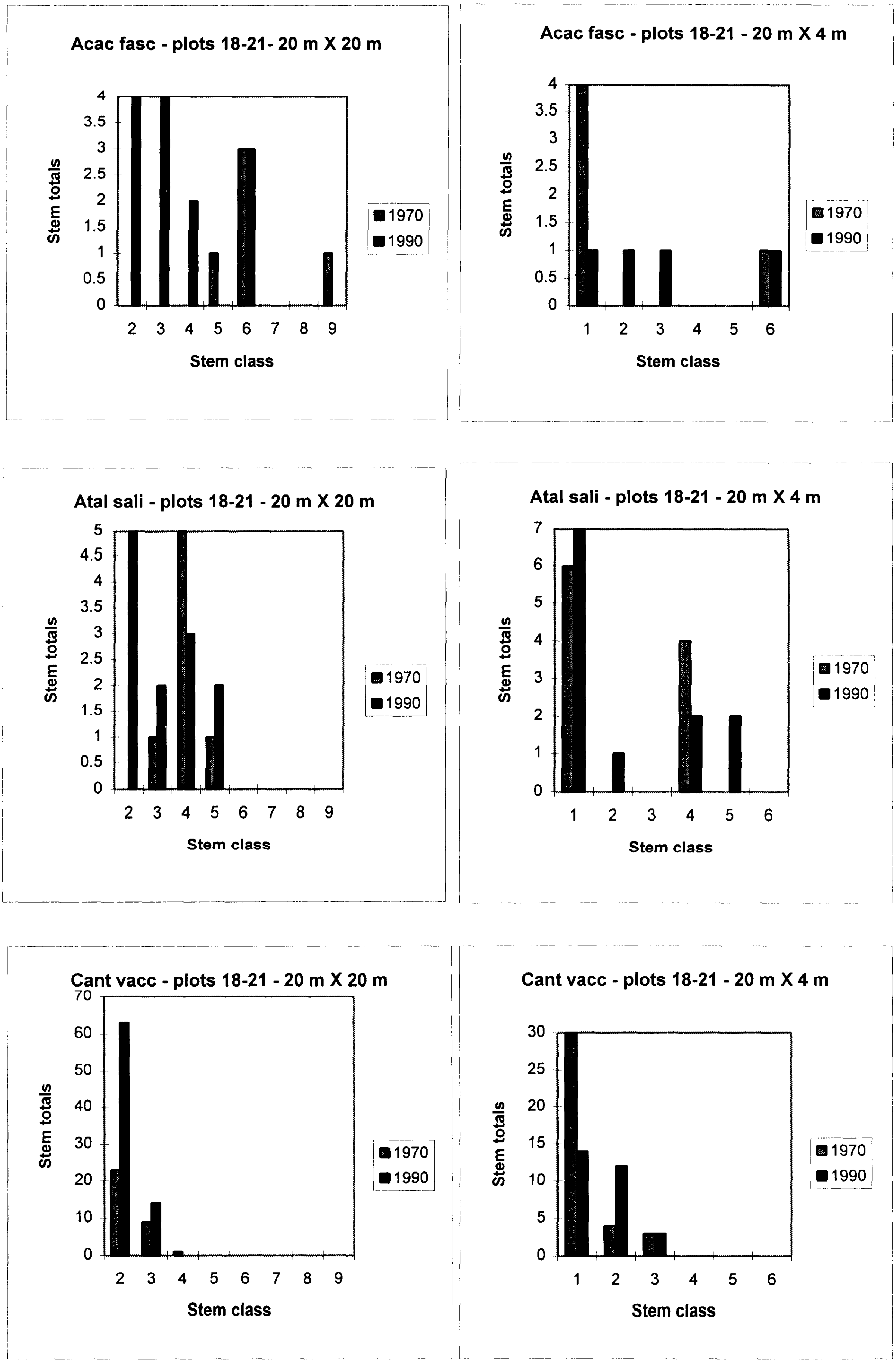
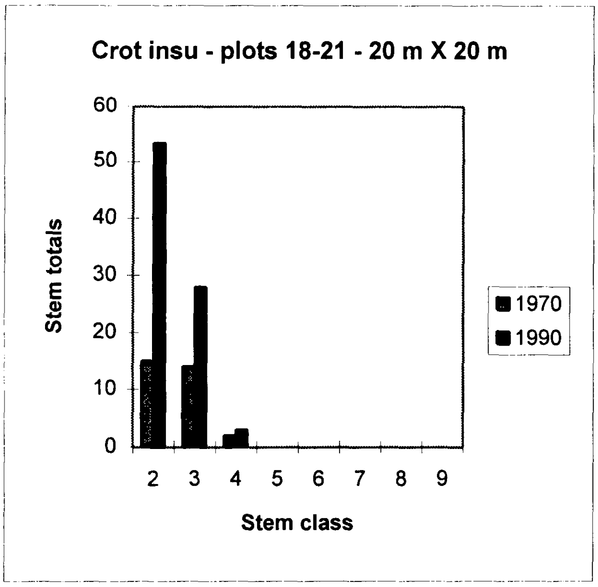
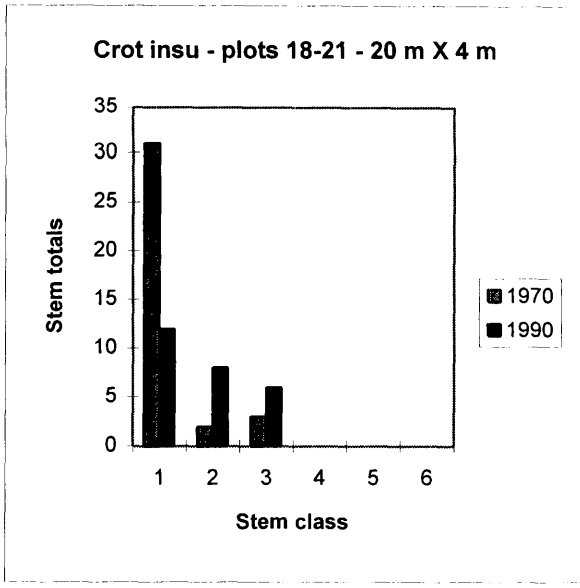
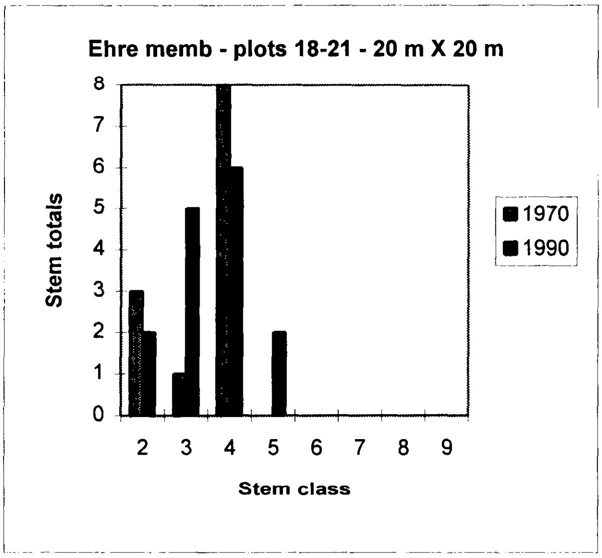
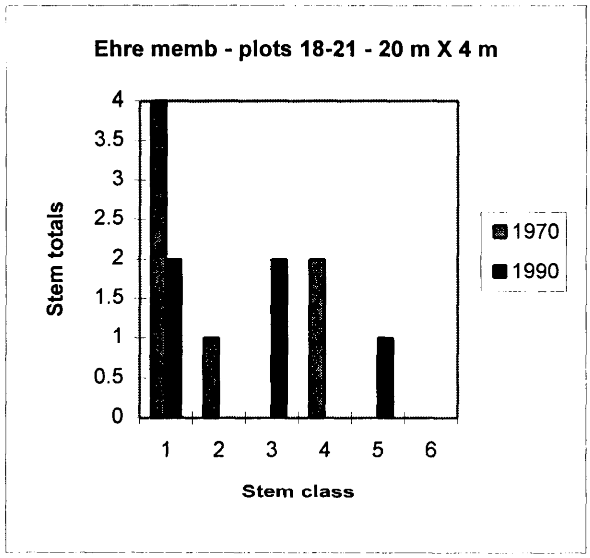


Figure 6.2 (cont.)









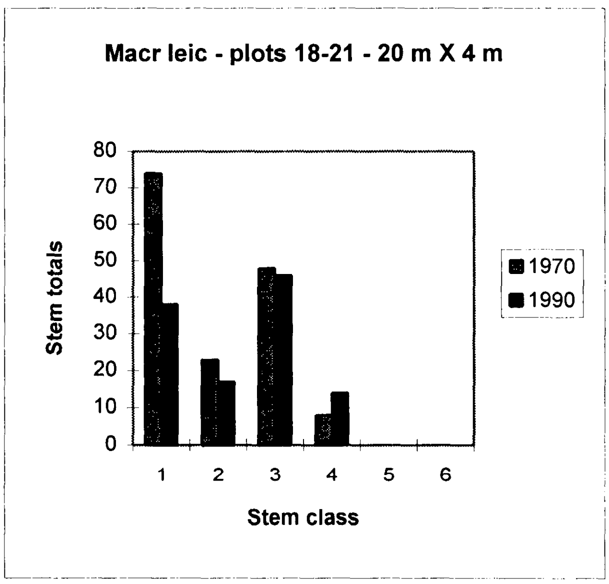


Figure 6.2 (cont.)

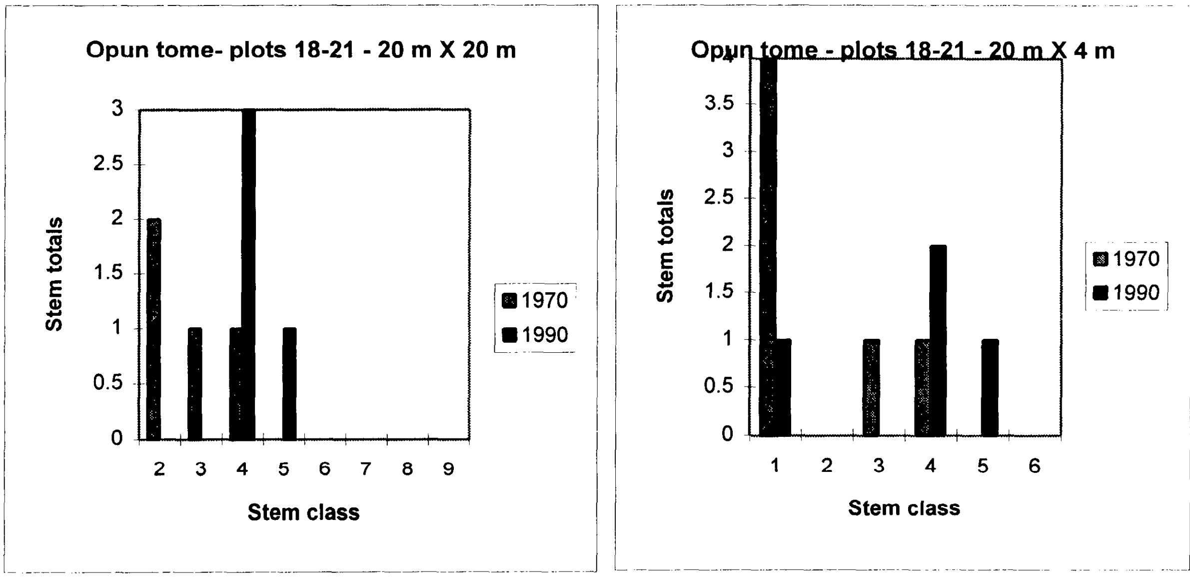


Figure 6.3 Comparison of stem counts in Brigalow RS plots 37-40 (group 5) measured in 1968/70 and in 1990/92.

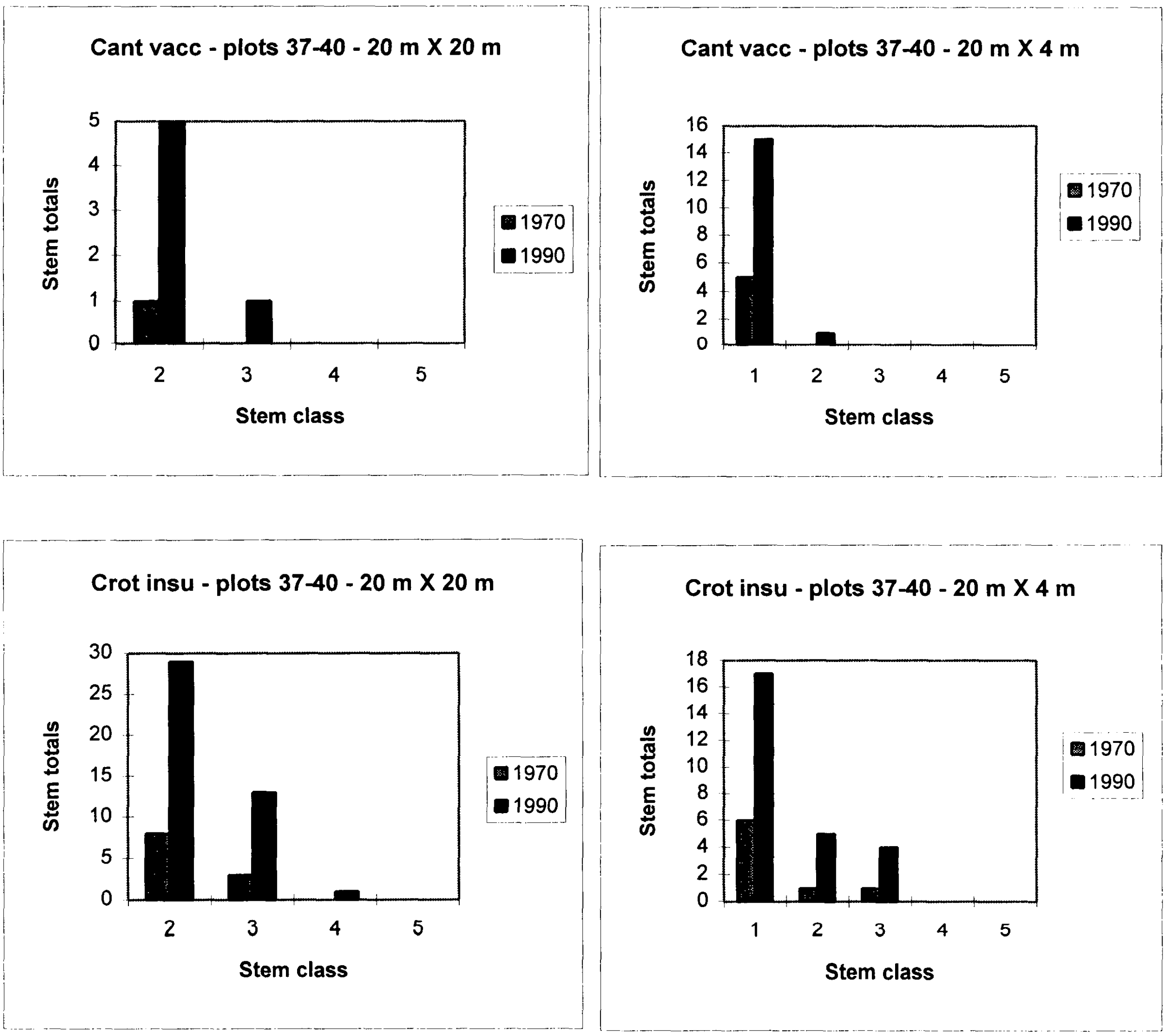
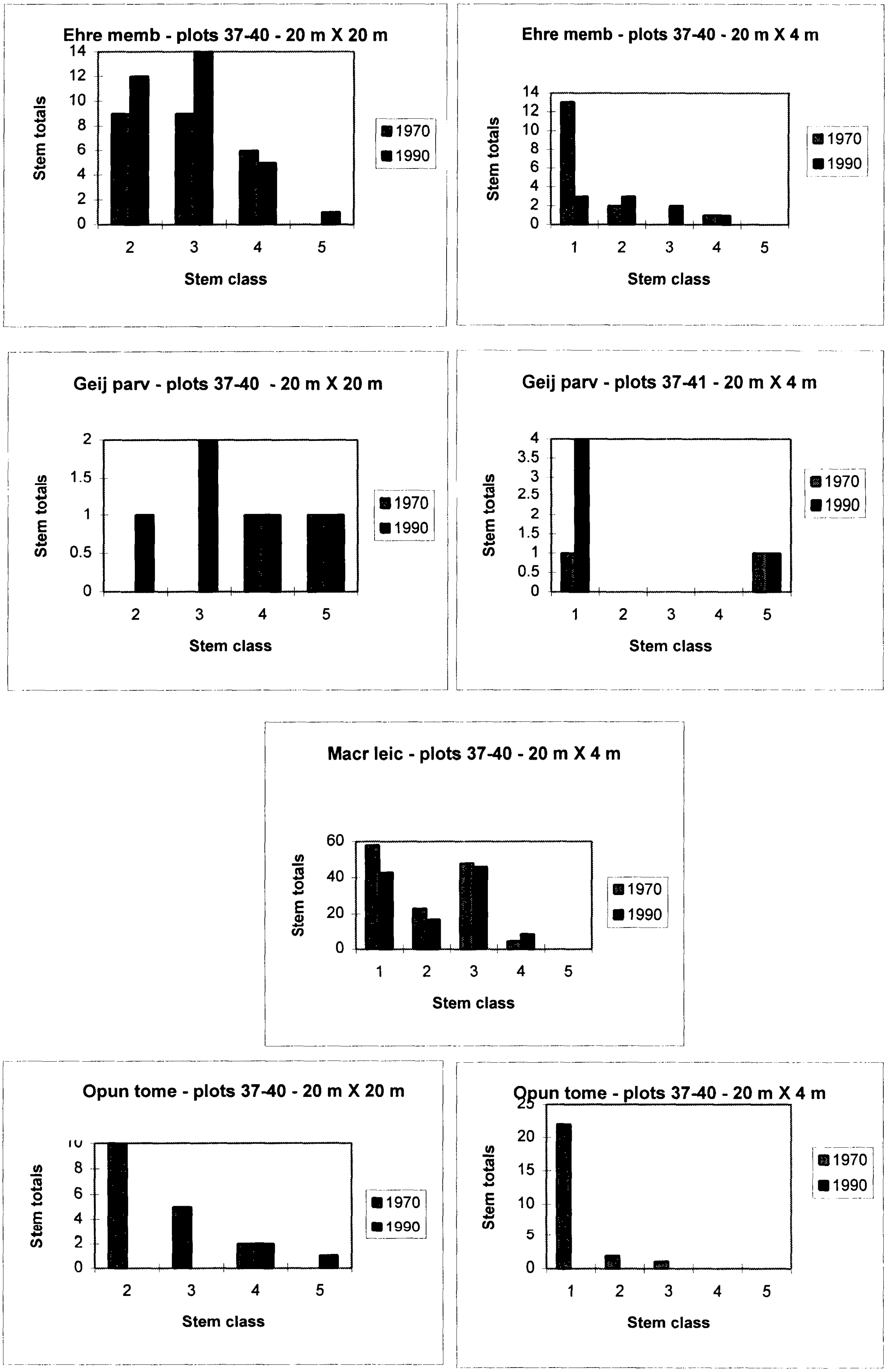


Figure 6.3 (cont.)



Geijera parviflora also showed an increase in the number of class 1 stems at the 1990-92 re-measurement, while class 2 and 3 stems recorded in the 20 m X 20 m plots also appear to have originated during this period.

Trends in counts of *Ehretia membranifolia* were similar for the two groups of plots, with increases in size classes 2 and 3, but correspondingly greater decreases in size class 1. Counts for group 5 (brigalow/bonewood) were approximately twice those for group 6 (bonewood).

Opuntia tomentosa also showed a broadly similar trend in the group 6 plots, but results differed markedly for the group 5 plots. Here the numbers of stems in the 20 m X 20 m plots fell from 17 to 3, with no class 2 or 3 stems. In the 20 m X 4 m subplots, this decrease was even more marked, with no stems at all recorded in 1990-92 (22 class 1 stems in 1968-70).

Counts of *Macropteranthes leichhardtii* stems were restricted, because of their high density, to the 20 m X 4 m subplots. Although the total stem counts for this species in 1968-70 were higher in the group 6 community (bonewood) than in the group 5 (brigalow-bonewood) community, in 1990-92 they were very similar. In both groups of plots the numbers of class 1 stems fell, the decrease being more pronounced in group 6. Both groups showed similar (slight) decreases in class 2 and 3 stems, but group 6 maintained higher numbers of class 4 (10-20 cm dbh) stems than group 5 (8-14 compared with 4-8).

6.3.3 Changes across boundaries between vegetation groups

Two groups of plots were re-measured to attempt to identify changes across boundaries (ecotones) between vegetation types. Plots 12-14 graded from brigalow (group 1) into brigalow-bonewood (group 5), while plots 58-61 extended from brigalow-bonewood into brigalow-mixed vine thicket (lacking bonewood) (group 2). There was no major change in site attributes between plots 12 and 14, but depth of soil A horizon increased (and height above datum decreased) from plot 58 to plot 61 (see **Figure 5.1**).

(i) Plots 12-14

The number of species in plot 12 (20 m X 20 m sample) increased slightly (from 11 to 12). Three species were gained (*Citriobatus spinescens, Croton insularis, Notelaea microcarpa*), while two were lost (*Croton phebalioides, Opuntia tomentosa*). In plot 13 the species count increased from 12 to 17 (*C. phebalioides* was lost and *Acacia fasciculifera, Atalaya salicifolia, C. spinescens, Eremocitrus glauca, N. microcarpa* and *Ventilago viminalis* gained). In plot 14 no species were lost, the count increasing from 13 to 15 (*Acacia fasciculifera* and *Brachychiton rupestris* gained).

Between the 1968-70 and 1990-92 measurements, numbers of stems in class 2 and above increased in all 3 plots - similar trends were shown by the corresponding data for the 20 m X 4 m subplots (see **Figure 6.4**). Counts of smaller (class 1) stems decreased between the two measurements (albeit only slightly in plot 13).

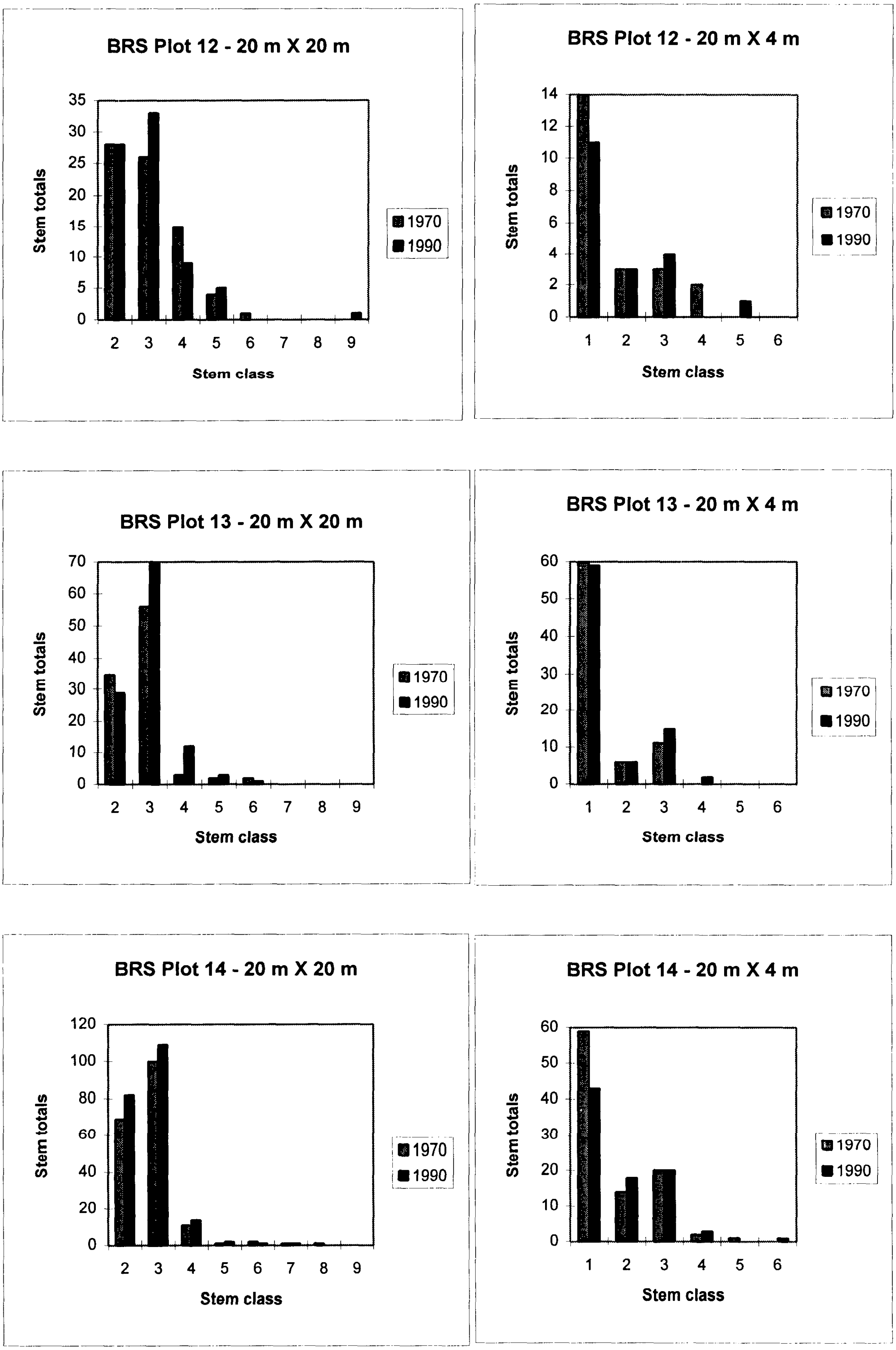
Changes in species composition based on the 20 m X 4 m subplots differed somewhat from those from the 20 m X 20 m plots. In plot 13, increases in the species count were similar (15 to 19 compared with 12 to 17 - see above), but only one species (*Eremocitrus glauca*) was recorded as new in both data sets. Species gained by individual subplots between 1968-70 and 1990-92 were *Acacia fasciculifera* (13), *Apophyllum anomalum* (13), *Diospyros humilis* (13,14), *Eremocitrus glauca* (13) and *Ficus opposita* (13). Species recorded in 1968-70 but not in 1990-92 were *Alectryon diversifolius* (plot 14), *Diplospora ixoroides* (14), *Ehretia membranifolia* (12), *Myoporum deserti* (12), *Notelaea microcarpa* (14), *Opuntia tomentosa* (12,14), *Planchonella cotinifolia* var. *pubescens* (13) and *Ventilago viminalis* (14).

Stem counts (classes 1-4) for several species are compared in **Table 6.4**. Significant decreases were shown by *Acalypha eremorum, Croton phebalioides* and *Opuntia tomentosa. Macropteranthes leichhardtii* occurred in all three plots and its total stem density increased between 1968-70 and 1990-92 in plots 12 and 13, but not in 14, where the number of class 1 stems decreased.

(ii) Plots 58-61

There were no consistent trends in results across the four plots (see **Figure 6.5**). There were increases in numbers of species recorded in each 20 m x 20 m plot (with an overall increase of 4

Figure 6.4 Comparison of total stem counts for vine thicket species in Brigalow RS plots 12-14 measured in 1968-70 and in 1990-92.



species). There was also an overall increase (5) in the species recorded from the 20 m x 4 m subplots, but 58 and 59 each lost 2 species (*Ehretia membranifolia* and *Opuntia tomentosa*), whereas 60 and 61 gained 7 and 3 species respectively, with no species lost.

Table 6.4 Comparison of stem counts* for 7 vine thicket species in BRS plots 12-14 measured in 1968/70 and in 1990/92.

		Plot 12 Size Class					Plot 13 Size Class					Plot 14 Size Class				
Species	**Year**	**1**	**2**	**3**	**4**	**Tot.**	**1**	**2**	**3**	**4**	**Tot.**	**1**	**2**	**3**	**4**	**Tot.**
ACALEREM	1970	0	0	0	0	**0**	18	0	0	0	**18**	4	0	0	0	**4**
	1990	0	0	0	0	**0**	8	0	0	0	**8**	1	0	0	0	**1**
ATALSALI	1970	1	0	0	0	**1**	2	0	0	0	**2**	1	0	0	0	**1**
	1990	2	0	0	0	**2**	11	0	0	0	**11**	2	0	0	0	**2**
CANTVACC	1970	3	0	0	0	**3**	3	0	0	0	**3**	5	0	0	0	**5**
	1990	4	0	0	0	**4**	4	0	0	0	**4**	8	2	0	0	**10**
CROTINSU	1970	0	2	0	0	**2**	0	2	0	0	**2**	6	0	0	0	**6**
	1990	1	1	2	0	**4**	1	1	2	0	**4**	4	2	1	0	**7**
CROTPHEB	1970	15	0	0	0	**15**	15	0	0	0	**15**	0	0	0	0	**0**
	1990	2	0	0	0	**2**	2	0	0	0	**2**	0	0	0	0	**0**
MACRLEIC	1970	1	1	1	1	**4**	9	4	10	0	**23**	30	12	19	1	**62**
	1990	5	2	1	0	**8**	18	1	12	1	**32**	22	13	19	2	**56**
OPUNTOME	1970	2	1	1	0	**4**	0	0	0	0	**0**	3	0	1	0	**4**
	1990	0	0	0	0	**0**	0	0	0	0	**0**	0	0	0	0	**0**

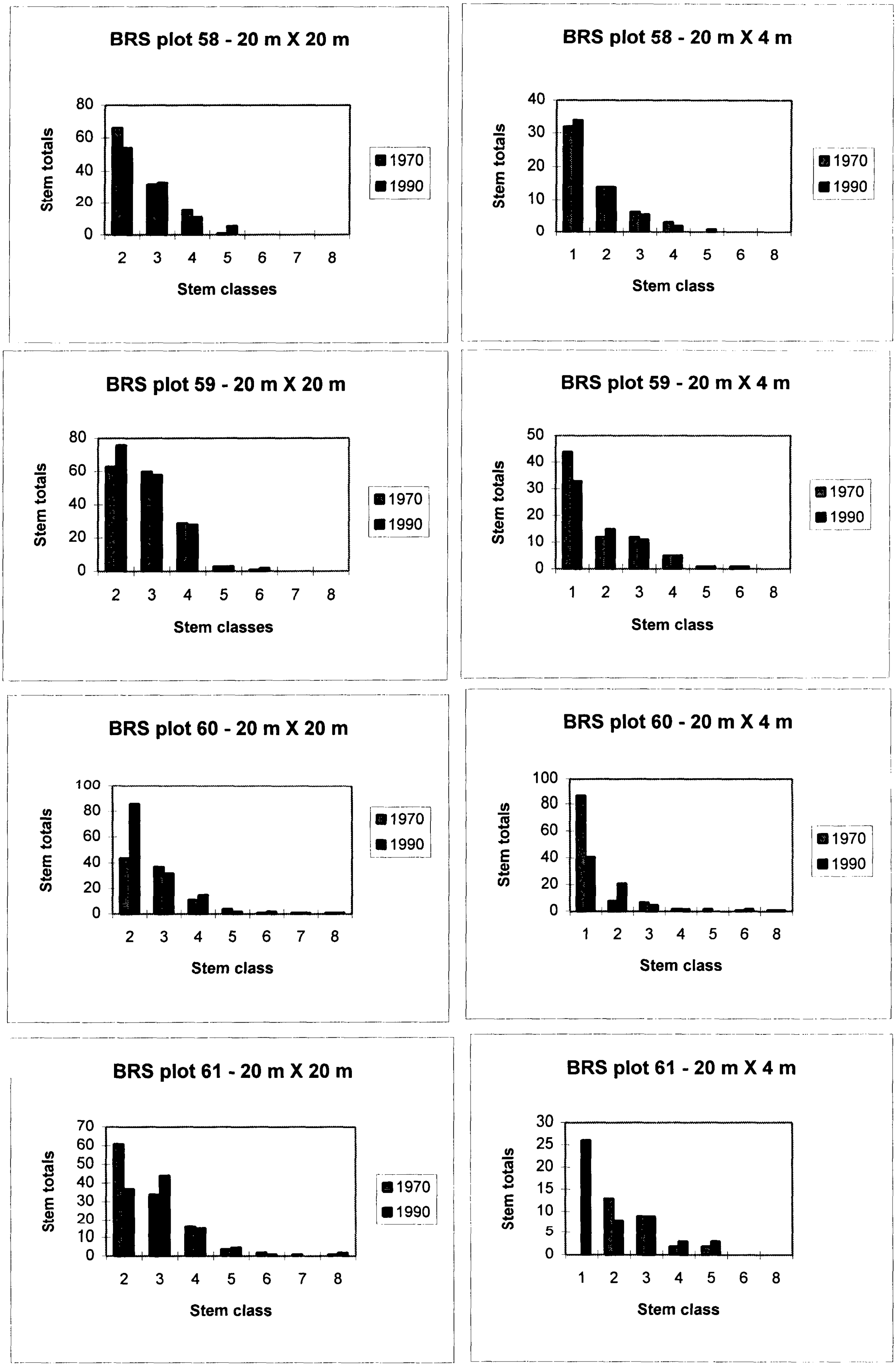
* Counts confined to 20 m x 4 m subplots.

The changes in stem density in plots 59 and 60 followed the general trend reported above, i.e. an increase in stems in class 2 and larger, but a marked decrease in numbers of class 1 stems (resulting in an overall decrease in total stem density) in the 20 m x 4 m sub plots. These changes were most pronounced in plot 60.

The results from plots 58 and 61 were the reverse of this general trend. There was a decrease in the number of class 2 stems, while class 1 stems increased - this was most marked in plot 61.

The species contributing most to these contrasting changes were *Alectryon diversifolius, Canthium vacciniifolium, Croton insularis* and *Ehretia membranifolia* (see **Table 6.5**). No class 1 stems were recorded in plot 61 for any of these species in 1970, compared with a combined total of 22 stems in 1990. Numbers of larger stems of *A. diversifolius* and *C. insularis* did not change, while those of *C. vacciniifolium* and *E. membranifolia* almost halved and doubled respectively.

Figure 6.5 Comparison of total stem counts for vine thicket species in Brigalow RS plots 58-61 measured in 1968-70 and in 1990-92.



In plot 60, the numbers of class 2 stems of each species doubled between 1968-70 and 1990-92. The numbers of class 1 stems, however, decreased for three of the four species (*Croton insularis* was not recorded from the 20 m X 4 m subplot in 1968-70).

Table 6.5 Comparison of stem counts for 8 vine thicket species in BRS plots 58-61 measured in 1968/70 and in 1990/92.

(a) 20 m x 20 m plots

		Plot 58				Plot 59				Plot 60				Plot 61			
Species	Year	2	3	4	5	2	3	4	5	2	3	4	5	2	3	4	5
ACACFASC	1970	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0
	1990	2	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0
ALECDIVE	1970	3	0	0	0	5	4	0	0	6	15	2	0	7	5	0	0
	1990	5	2	0	0	1	2	1	0	11	8	3	0	5	7	0	0
CANTVACC	1970	16	2	0	0	23	4	0	0	16	10	1	0	27	13	0	0
	1990	21	3	0	0	25	4	0	0	36	4	0	0	15	7	0	0
CROTINSU	1970	0	1	0	0	0	1	0	0	3	1	0	0	6	1	0	0
	1990	1	0	0	0	1	0	0	0	6	2	0	0	3	4	0	0
EHREMEMB	1970	0	1	0	0	2	0	0	0	6	6	2	0	8	3	2	0
	1990	1	1	0	0	1	0	0	0	15	9	6	0	8	13	2	0
GEIJPARV	1970	0	0	0	1	0	0	1	1	1	0	4	0	0	0	7	1
	1990	0	0	0	1	0	0	0	1	0	1	3	0	0	0	5	2
MACRLEIC	1970	45	25	15	0	30	50	25	0	3	1	1	0	0	0	0	0
	1990	20	25	10	5	45	50	25	0	4	5	0	0	0	0	0	0
OPUNTOME	1970	1	2	0	0	2	0	1	0	0	0	0	0	1	0	1	0
	1990	0	0	1	0	0	0	1	0	1	0	1	0	0	0	0	1

(b) 20 m x 4 m subplots

		Plot 58					Plot 59					Plot 60					Plot 61				
Species	Year	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
ALECDIVE	1970	2	1	0	0	0	0	2	1	0	0	16	1	4	0	0	0	0	1	0	0
	1990	1	2	0	0	0	1	1	1	0	0	9	3	2	0	0	11	0	0	1	0
CANTVACC	1970	18	4	1	0	0	22	4	1	0	0	35	4	2	0	0	0	6	5	0	0
	1990	21	8	0	0	0	13	4	0	0	0	10	12	0	0	0	4	4	3	0	0
CROTINSU	1970	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	1990	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	6	0	0	0	0
EHREMEMB	1970	1	0	0	0	0	2	0	0	0	0	18	2	1	2	0	0	5	1	0	0
	1990	0	0	0	0	0	0	0	0	0	0	0	3	3	2	0	1	4	4	0	0
GEIJPARV	1970	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0
	1990	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2	0
MACRLEIC	1970	9	9	5	3	0	12	6	10	5	0	0	0	0	0	0	0	0	0	0	0
	1990	11	4	5	2	1	17	9	10	5	0	4	0	0	0	0	0	0	0	0	0
OPUNTOME	1970	2	0	0	0	0	6	0	0	0	0	5	0	0	0	0	0	0	0	0	0
	1990	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

The density of *Macropteranthes leichhardtii* decreased slightly in plot 58 and increased in plots 59 and 60. In plot 60 all stems of size class 2 and greater were counted - these increased from 5 in 1968-70 to 9 in 1990-92. *Macropteranthes leichhardtii* was also recorded from the 20 m X 4 m subplot of plot 60 in 1990-92 - it was not present in 1968/70.

6.4 Results from measurement of growth of vine thicket tree species

Because of the relatively low numbers of several vine thicket tree species in the 16 plots re-measured in 1990 and 1992, an additional 75 trees were located and re-measured elsewhere along the transect (but still in vine thicket vegetation). The results from the total sample of 305 trees (20 species) are summarised in **Table 6.6.** Growth of each species was calculated as the percentage increase in basal area per year (per annum increment - PAI). Basal area data for individual trees are presented in **Appendix 8**.

Table 6.6 Growth (per annum increment - PAI) of vine thicket tree species at Brigalow Research Station from 1968 to 1992.

Species	No.*	Dbh (cm) (1992)		Basal area (cm^2)		PAI (%)	
		Mean	Range	1968	1992	Mean	Range
ACACFASC	18(1)	23.1	3.6-39.0	8129	10626	1.28	0.09-15.14
ACACHARP	32(10)	22.6	6.8-43.2	11239	16758	2.05	0.15-61.3
ALECDIVE	24(1)	8.3	2.8-23.4	1382	1654	0.82	0.61-13.7
APOPANOM	22	10.1	3.2-24.0	2277	2638	0.66	0.27-12.99
ATALSALI	16(1)	14.9	5.1-32.2	2940	3964	1.45	0.12-14.21
BRACRUPE	22(2)	39.5	3.4-181.9	41519	53100	1.16	0.02-60.0
DIOSHUMI	13(1)	10.6	3.2-30.5	1436	1809	1.08	0.21-24.5
EHREMEMB	41(1)	9.5	3.0-21.3	2519	4067	2.56	0.20-19.06
FLINCOLL	17	9.6	4.4-18.1	586	1547	6.84	1.43-22.29
GEIJPARV	29	19.1	7.0-47.5	8281	10311	1.02	0.32-22.9
CAPPLORA	5			568	597	0.21	
CASSTOME	7			186	274	1.97	
CASUCRIS	9			6675	8437	1.10	
CROTINSU	9			205	334	2.62	
DENHOLEA	5			75	156	4.53	
DENHPITT	4			299	331	0.45	
EUCACAMB	3			5968	6917	0.66	
LYSICARR	6			1114	1989	3.27	
PLANCOPU	2			306	655	4.76	
VENTVIMI	4			6354	6125	-0.15	

*Numbers of trees surviving in 1992 - the figures in parenthesis are the numbers of deaths or (in the case of *Alectryon diversifolius*) losses of major stems.

Growth increments for each species showed considerable variation, but the highest growth rates overall were recorded for *Flindersia collina* (mean PAI of 6.84%) while *Denhamia oleaster*

(4.53%), *Lysiphyllum carronii* (3.27%), *Croton insularis* (2.62%) and *Ehretia membranifolia* (2.56%) also showed relatively vigorous growth.

Because of the significance of *Macropteranthes leichhardtii* as a dominant species, a sample of 150 trees was chosen from the 1968/70 site data, and an attempt was made to locate and re-measure them in March 1995. 90 individual trees were identified with reasonable certainty. Most stems were relatively small, with only 2 greater than 10 cm diameter. Growth of this species over the 25 years has been very slow - more than half the stems (57/90) were recorded in the same (≥2.5 cm) size class in 1995 as in 1968/70 and the remainder had increased by only one 2.5 cm interval. This is in marked contrast to most other tree species - of a total of 108 stems of comparable (initial) size (i.e. <5 cm dbh) re-measured in 1992, only 27 were recorded in the same diameter class as in 1970. Of these other species, least growth was shown by *Apophyllum anomalum* (7/18 the same size), *Diospyros humilis* (3/10), *Ehretia membranifolia* (10/35) and *Alectryon diversifolius* (4/20).

1970 and 1990 dbh data for ten species (*Acacia fasciculifera, A. harpophylla, Alectryon diversifolius, Apophyllum anomalum, Atalaya salicifolia, Brachychiton rupestris, Diospyros humilis, Ehretia membranifolia, Flindersia collina* and *Geijera parviflora*) were plotted against growth curves developed for each species using the generalised growth model of Botkin, Janak and Wallis (1972) (see **Figure 6.6**). Numbers of individuals of the remaining species, notably *Croton insularis*, were inadequate for modelling purposes.

Generalised growth curves were derived from the formula

$$\delta D = GD\,[\,1 - \delta H / D_{mzx} H_{max}] \,/\, [274 + 3b_2 D - 4b_3 D^3]$$

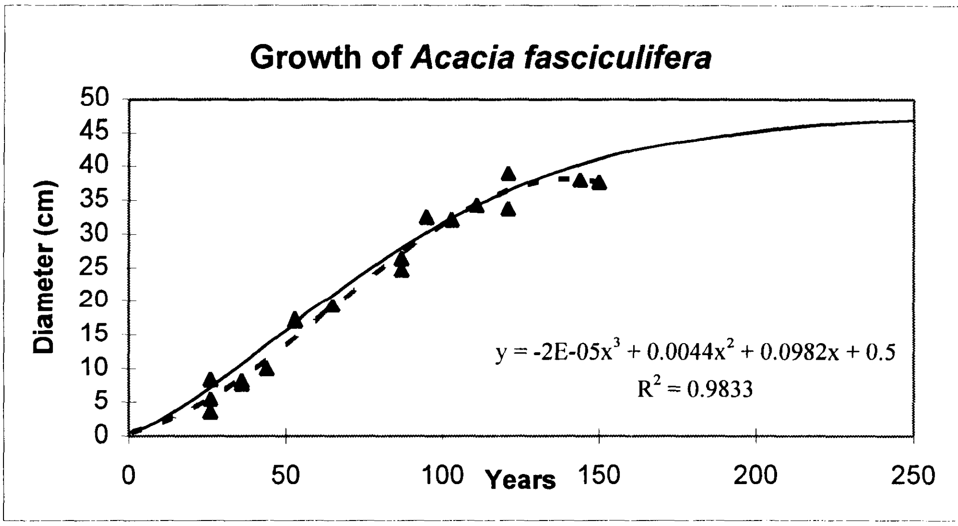
where D_{max} and H_{max} were the maximum diameter and maximum height recorded for a particular species during the detailed survey (see **Chapter 3**). This formula is a simplified form of the growth rate equation used in the subroutine GROW, which was itself based on the JABOWA equation for a tree growing under optimum conditions (Botkin *et al.* 1972).

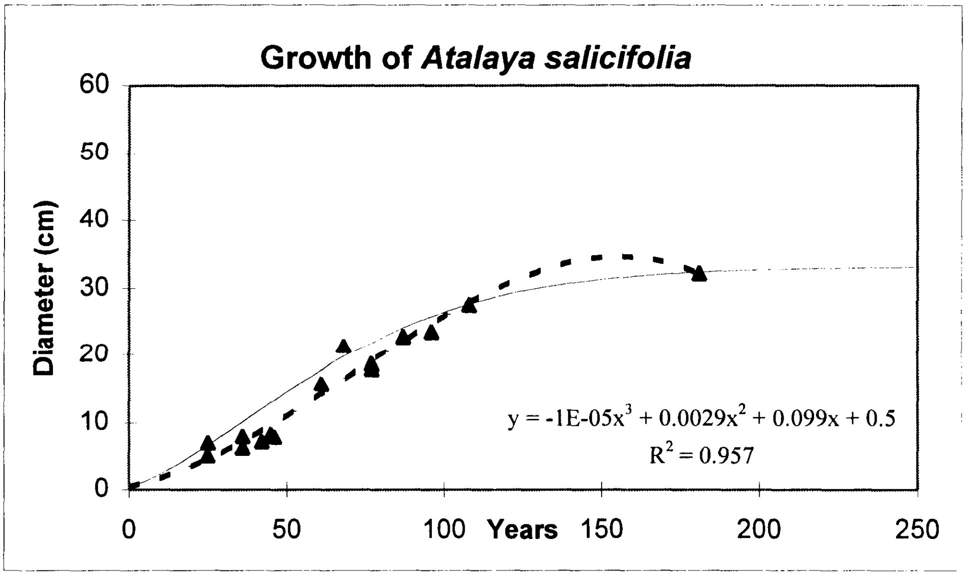
The constant G was derived for each species using the formula recommended by Botkin *et al.*.

$$\delta D_{max} \approx 0.2\ G\ D_{max} / H_{max}$$

$$\therefore G \approx 5\ \delta D_{max}\ H_{max} / D_{max}.$$

Figure 6.6 Growth models for 6 vine thicket tree species based on data from Brigalow Reasearch Station measured in 1968/70 and in 1990/92.





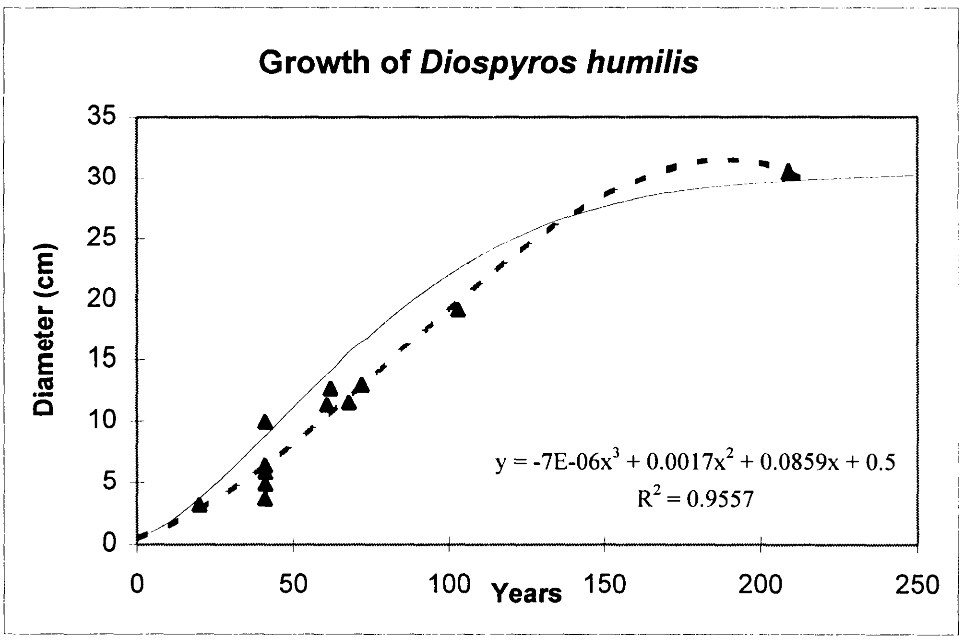
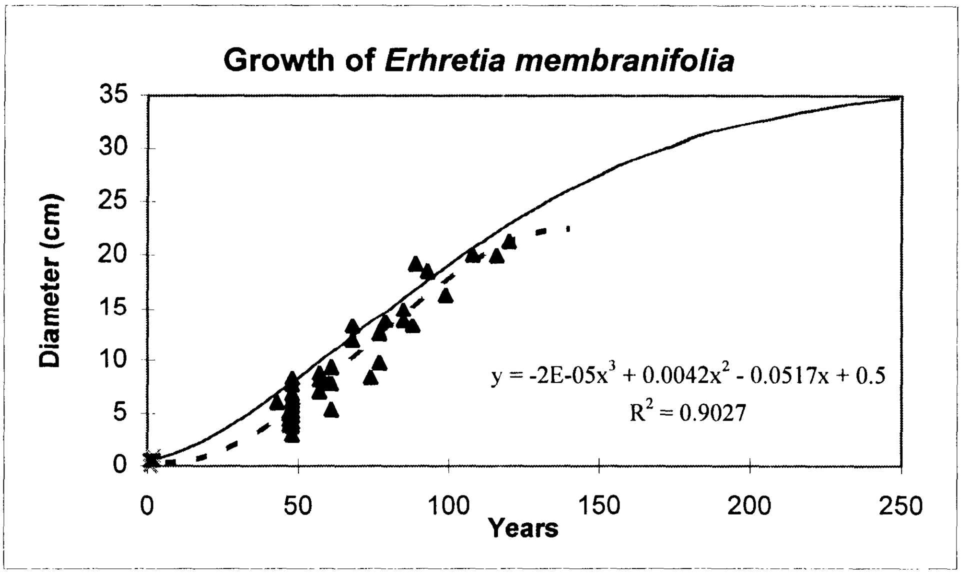
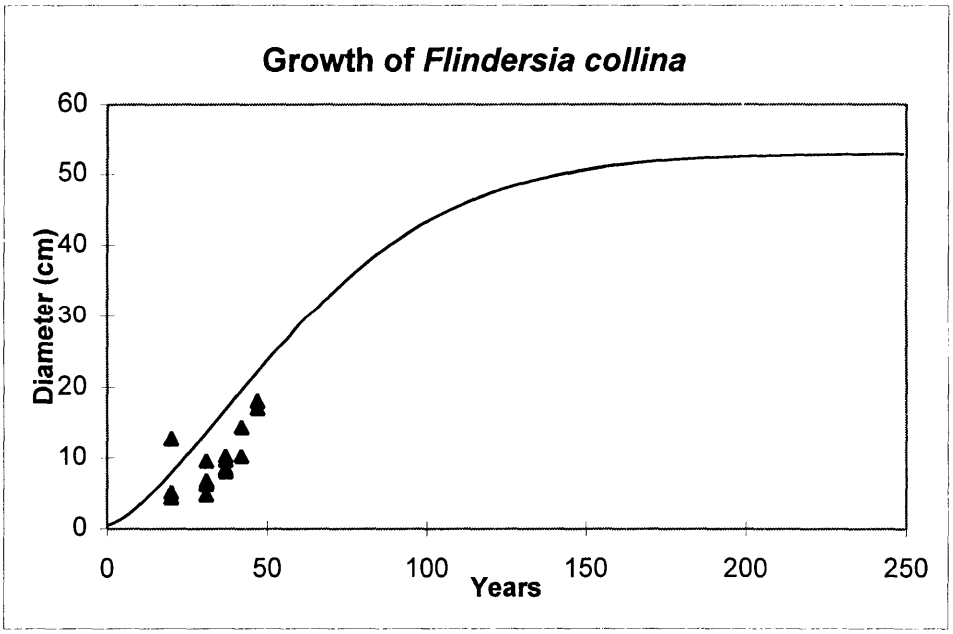
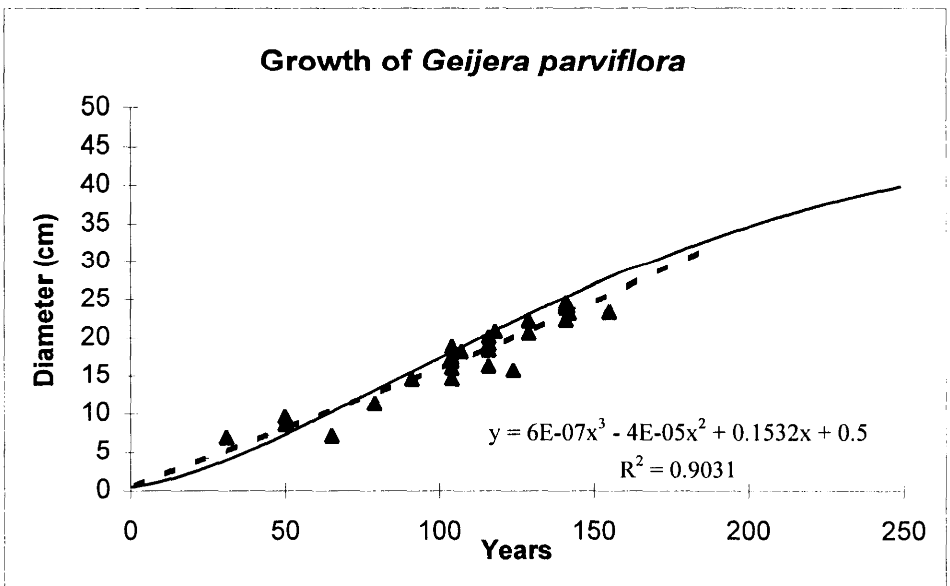


Figure 7.6 (cont.)







The growth records from the transect were then plotted on the graph using the assumption that the 1968/70 values lay on the curve. This provided an estimate of age of the tree in 1968/70 and the age in 1990/92 was determined as the initial estimate plus 20 years. A trend line was then produced for the plotted points for comparison with the generalised growth curve.

Growth curves for *Acacia fasciculifera, Atalaya salicifolia, Diospyros humilis, Ehretia membranifolia, Flindersia collina* and *Geijera parviflora* are presented in **Figure 6.6.**

Growth data for 18 tree and shrub species over 11 years (1984-95) at Yarraman, calculated as increase in basal area of stems > 3m high, are summarised in **Table 6.7.**

Table 6.7 Growth (per annum increment - PAI) of vine thicket tree species over 11 years (1984-1995) at Yarraman, south-east Queensland.

Species	Dean Logging Area				Tower Logging Area			
	No.*	Basal Area (sq cm)		PAI	No.	Basal Area (sq cm)		PAI
		1984	1995			1984	1995	
ARYTFOVE	22	822.39	908.03	0.95	63(11)	1967.43	2357.28	1.80
AUSTBIDW	4	132.40	145.60	0.91	14(1)	359.66	408.93	1.25
BALOINOP	4	358.74	381.08	0.57				
CANTLAMP					4	556.44	640.59	1.38
CANTVACC					11	276.27	325.56	1.62
CAPPARBO	3	1040.87	1146.66	0.92	5(2)	541.66	582.86	0.69
CASEMULT	7(7)	54.38	79.05	4.16				
CLEICUNN	11	91.88	105.32	1.33	3(2)	16.38	19.29	1.63
CROTACRO	5(2)	220.36	223.01	0.11	5(2)	218.31	246.34	1.17
CROTINSU	5(3)	224.19	278.36	2.20	30(9)	1675.82	1906.64	1.25
CUPAPARV					13	308.54	427.45	3.50
ELATXYLO	16(1)	717.74	805.09	1.11				
EXCODALL	45	2025.44	2215.56	0.85	11(6)	83.37	94.19	1.18
FLINCOLL	7	1033.74	1105.20	0.63				
GEIJSALA	3	2236.12	2314.29	0.32				
PLANCOCO	3	1044.84	1085.34	0.35				
PLANMYRS					23(3)	400.43	492.93	2.10
STRYAXIL					7	40.71	45.67	1.11

* Number of surviving trees and shrubs >3m high - the figure in parenthesis indicates the number of individuals that had died and/or could not be re-located in 1995.

Deaths from drought also varied between the two Yarraman sites; for example several stems of *Arytera foveolata* and *Excoecaria dallachyana* died in the Tower Logging Area plot but none in the Dean LA plot. *Croton acronychioides* and *C. insularis* died in both plots, with a broad range of stem sizes being affected, a trend that was also noted in several Central Queensland vine thicket sites in July/August 1994. Large trees of *Flindersia xanthoxyla* and *Drypetes deplanchei* died in the Tower LA plot, but three specimens of *Argyrodendron trifoliolatum*, a species more typically associated with moister rainforest types, survived with slight crown death.

6.5 Modes of regeneration and dispersal of vine thicket tree species

Data collated from the literature (e.g. Floyd 1989) and a range of unpublished sources (see **Acknowledgments**) are presented in **Appendix 7**.

Data on ease of germination were available for 51 species. Of these 27 were known to germinate readily, while 24 were regarded as requiring a degree of treatment. Vegetative regrowth from basal sprouts and/or root suckers was recorded in 34 of the 79 species (**Appendix 7**).

Relatively similar numbers of species were recorded as animal-dispersed (44 + ?9) and gravity-dispersed (46), with 27 species recorded as having both forms of dispersal. Twenty-two species are wind-dispersed, and 5 have been recorded as water-borne. The method of dispersal of *Excoecaria dallachyana* is not known, and the roles of birds in the dispersal of *Acacia fasciculifera, A. harpophylla, Archidendropsis thozetiana, Croton acronychioides, C. insularis* and *Pleiogynium timorense* remain uncertain (see **Appendix 7**).

Wind-dispersed species make up a significant component of the canopy and emergent layers in many vine thickets. These species include *Cadellia pentastylis, Macropteranthes* spp., *Atalaya* spp., *Gyrocarpus americanus, Homalium alnifolium, Backhousia* spp., *Flindersia* spp. and *Ventilago viminalis.* The major exceptions to this trend among the larger trees are *Brachychiton australis, B. rupestris* and *Geijera parviflora*. Many of the lower canopy and understorey species on the other hand have predominantly fleshy fruit and/or arils and are bird-dispersed. Several members of the Euphorbiaceae (e.g. *Croton insularis*) have fruit which open explosively, scattering the seed clear of the parent plant (see **Appendix 7**).

6.6 Discussion

Results from re-measurement of vine thicket and brigalow/vine thicket plots in the Brigalow Research Station transect indicate a lack of recruitment into the smallest size classes (i.e. stems <2.5cm dbh but >30cm high) since 1968-70. This may be due to a number of causes such as a lack of suitable conditions for germination and growth of tree and shrub species and/or high mortality caused by drought or grazing pressure. Although livestock have been excluded from the transect since its establishment, large numbers of black-striped wallabies (*Macropus dorsalis*) use the vine thicket for shelter, feeding out into the surrounding sown pastures and crops. Prior to clearing, the area would probably have supported much lower densities, but the increased pasture and water, coupled with removal of the wallabies' main predator, the dingo, has meant that pressure on the remnants of natural vegetation has increased enormously.

Although black-striped wallabies are regarded primarily as grazers, their diet may consist of up to 20% of browse in dry periods (Ellis, Dawson and Tierney 1992). Given the large population of wallabies, this could well account for the apparent lack of shrub and tree regeneration. Browsing damage was noted in *Canthium vacciniifolium*, and there were considerable areas of soil disturbance where wallabies congregated.

Only limited data are available from quadrat measurements of the ground layer along the centre line of the transect. Numbers of the sub-shrub *Abutilon oxycarpum* decreased dramatically between the 1968-70 and 1990-92 measurements. This species is relatively short-lived and occupies the more open situations within vine thickets. It regenerates readily in favourable seasons, and its relatively low density in 1990-92 may be more a reflection of seasonal conditions than an indication of browsing of the understorey. Numbers of seedling *Croton insularis* and *Opuntia tomentosa* were also comparatively low, and the resurrection fern *Cheilanthes distans*, which had been common in 1968-70, was recorded only once in 1990-92. The annual rainfall for 6 of the 8 years prior to 1990 exceeded the long-term median value (708 mm). However, this was due mostly to unusually wet autumns and winters.

In considering whether this apparent failure of recruitment might be a result of seasonal conditions, it is noted that large numbers of seedling *Acacia fasciculifera* were recorded by R.W.Johnson at Brigalow Research Station in late April 1963 (prior to the establishment of the transect and collection of rainfall data). These survived and some have been subsequently monitored in the transect, e.g. plots 18-21. The rainfall records for "Coorada" and "Banana", the nearest recording stations (see **Table 6.2**) indicate widespread heavy rain in March 1963 (270 and 176 mm respectively). "Coorada" also recorded 200 mm in March 1962, but apart from 76 mm in July, rainfall for 1962 was generally below average. Rainfall at "Coorada" during winter and spring of 1963 was also low, and the fall of 70 mm recorded in August 1963 may well have been crucial for the survival of the *A. fasciculifera* seedlings at Brigalow Research Station.

Several periods of consistently higher than average rainfall have occurred over the 20 years since establishment of the transect, but these have mostly been during late autumn and winter, except for the 1967/68 and 1987/88 summers. Had any regeneration taken place, it would most likely have succumbed during the severe drought periods which followed.

Although the numbers of tree and shrub stems (> 2.5cm dbh) have increased for a majority of species in both the brigalow/vine thicket and vine thicket communities, this accounts for only a small component of the decrease in the smallest (class 1) stems, suggesting that there has been considerable mortality ("self-thinning"). In the case of *Macropteranthes leichhardtii*, this effect has been more pronounced in the vine thicket community (vegetation group 6) than in the brigalow/vine thicket community (vegetation group 5). Similar self-thinning occurred with *Acacia fasciculifera*, *Canthium vacciniifolium* and *Croton insularis* in the group 6 plots and also with *Ehretia membranifolia*, which remained more abundant in the brigalow/vine thicket community. The numbers of class 1 stems of *Canthium vacciniifolium, Croton insularis* and *Geijera parviflora* in the brigalow/vine thicket community, on the other hand, were greater in 1990-92 than in 1968-70, suggesting that most recruitment has survived.

Densities of the alien *Opuntia tomentosa* have dramatically decreased over the 20-24 year period in all plots, with very few stems of any size. Seedlings were common along the transect, however, and this relatively short-lived species could perhaps be considered to represent, together with *Croton insularis*, an early secondary or "nomad" element (Hopkins *et al.* 1977) within this community.

Amongst the larger trees for which growth data were gathered (see **Table 6.6**), only *Acacia harpophylla* showed significant mortality over the 20-24 year period. This has been an on-going process judging by the numbers of fallen stems along the transect. Old logs of *Eucalyptus cambageana* are also present. These deaths, combined with the increased diversity and density of the vine thicket understorey suggest that the brigalow/vine thicket community (group 5) may be undergoing a form of successional change towards vine thicket.

The extent to which this succession may progress on the heavier cracking clay soils is debatable. Occurrences of vine thicket were quite limted on these latter soils, which typically are occupied by *Acacia harpophylla* - *Casuarina cristata* communities, vegetation group 4 for example. Apart from *Geijera parviflora*, few vine thicket species appear tolerant of heavily weathered, gilgaid clays.

Counts of *Macropteranthes leichhardtii* from the two subsets of ecotonal plots (i.e. 12-14 and 58-61) suggest that this species may be gradually expanding its distribution within the transect. In plot 60, for example, the number of larger (class 2 and larger) stems increased from 5 to 9, while it was also recorded (for the first time) in the 20 m X 4 m subplot. Although the duplex soils along this section of the transect presently carry a brigalow/vine thicket community which lacks *Macropteranthes*, its absence may be less related to present-day environmental conditions than to past history of the site (perhaps events such as severe drought and/or fire).

The incremental growth data recorded for vine thicket tree species (**Table 6.6**) shows great variation, which would be a reflection of individual vigour and competetive effects as well as varying site conditions along the transect. There are also problems of repeatability and consistency between dbh measurements because of the low stature and multiple stems of many trees in this community. Another major source of variation is the considerable dry season shrinkage noted for example by Unwin and Kriedemann (1990) in SEVT trees (*Acacia aulacocarpa* and *Melia azedarach*) at Forty-Mile Scrub. This effect was also documented in dry seasonal forests in Ghana (Swaine *et al.* 1990). As a result of the variation within the data set (see **Table 6.6**), none of the differences between the mean growth rates of the 10 species at Brigalow Research Station was significant.

No growth data were available from other vine thicket communities, but limited comparisons can be made with 11 years' data from tagged trees and shrubs in two plots in araucarian vine forest at Yarraman in south-eastern Queensland (see **Table 6.7**). Growth rates for two species common to Brigalow RS and Yarraman, *Flindersia collina* and *Croton insularis*, appeared to be considerably lower for Yarraman than for Brigalow, but this may be a result of the adverse seasonal conditions experienced at Yarraman and possible stem shrinkage as noted above. It may also be due to competition and shading, since araucarian vine forests are generally taller and denser than the vine thickets.

These differences in growth rates may also be explained in terms of the relative sizes of the trees in each sample and the growth curves of Botkin *et al.* (see **Figure 6.6**). The trees measured at

Brigalow RS are smaller than those from Yarraman (see **Tables 6.6** and **6.7**) and would therefore be expected under similar environmental conditions to have faster rates of growth.

The growth curves derived for *Acacia fasciculifera, Atalaya salicifolia, Diospyros humilis, Ehretia membranifolia, Flindersia collina* and *Geijera parviflora* all differ slightly from the generalised (Botkin) model (see **Figure 6.6**). In *A. fasciculifera, A. salicifolia* and *Diospyros humilis*, there is a long period of relatively slow growth, followed by a steeper growth curve than that shown by the generalised model. This may be interpreted as indicating a longer period of establishment, including development of an extensive root system and/or a longer period of suppression due to older competing stems.

Ehretia membranifolia closely parallels the Botkin model in the early stages of growth, but it would appear from then on to grow much more slowly than predicted by the generalised model. The *Flindersia collina* data was too clustered (i.e. all smaller stems) to generate a satisfactory trend line, while data for *Geijera parviflora* suggests a relatively even, slow growth rate.

The ability of vine thicket species to regenerate vegetatively is demonstrated by data from areas which were pulled and burnt at Brigalow Research Station during the late 1960s (see **Table 6.8**). *Ehretia membranifolia* resprouted at rates of up to 500 suckers per ha and despite its acknowledged susceptibility to fire, *Macropteranthes leichhardtii* did produce some regrowth. It should be noted that the intensities of these fires would be far more severe than any occurring under natural conditions.

In late 1991 a wildfire burnt an area of *Macropteranthes* - dominant vine thicket in the Ka Ka Mundi sector of Carnarvon National Park. In May 1993, Melzer (pers. comm.) recorded densities of up to 2000 and 1000/ha respectively for re-sprouting *Carissa ovata* and *Alstonia constricta* and also noted small numbers of suckers of *Ehretia membranifolia, Backhousia angustifolia* and *Macropteranthes leichhardtii.* Seedlings of the pioneer tree *Codonocarpus attenuatus* were also abundant (up to 1600/ha).

Table 6.8 Counts of resprouting vine thicket species following clearing and burning at Brigalow Research Station (Johnson, unpubl.).

	Burn 1 Counted Aug 1966						Burn 2 Counted Sept 1967					Burn 3 - undated						
	Plot						Plot					Plot						
SPECIES	**1**	**2**	**3**	**4**	**5**	**Tot.**	**1**	**2**	**3**	**4**	**Tot.**	**1**	**2**	**3**	**4**	**5**	**Tot.**	**O.T**
ACACHARP	2				11	**13**	3		2		**5**	3	6			7	**16**	**34**
ALECDIVE						**0**			1		**1**		1				**1**	**2**
ATALSALI	1		3			**4**		1		1	**2**			2			**2**	**8**
CARIOVAT	1					**1**			1		**1**		1				**1**	**3**
CASSTOME						**0**		1			**1**		1				**1**	**2**
EHREMEMB	6	4	18	7	4	**39**	2	6	4	5	**17**	4	2	6	13	1	**26**	**82**
EUCACAMB			1			**1**				1	**1**						**0**	**2**
MACRLEIC		1	1	1		**3**				1	**1**		1	1	1		**3**	**7**
OPUNTOME	3	2			1	**6**	1	1	1		**3**	1				1	**2**	**11**
OWENVENO		3			7	**10**	2		1		**3**					5	**5**	**18**
CAPPLASI	1		1	2	1	**5**	1	1		1	**3**	1			1		**2**	**10**
CISSOPAC				3		**3**			2		**2**		4	1	1	2	**8**	**13**
JASMDIRA						**0**			2	1	**3**		1				**1**	**4**
PARSLANC	3	2				**5**					**0**						**0**	**5**

The floristic diversity of rainforests may depend upon the availability of appropriate animal vectors for dispersal. This would not seem to be a limiting factor for most areas of vine thicket. Altogether more than 30 species of frugivorous birds have been recorded from vine thicket habitat within the Brigalow Belt (see **Appendix 8**).

Green (1993) reported results of observation of birds visiting 23 rainforest plant species in the Border Ranges region in 1988-90. Eight of these plant species also occur in the eastern vine thickets - *Diospyros geminata, Elaeocarpus obovatus, Melia azedarach, Ficus fraseri, F. platypoda, Maclura cochinchinensis, Jagera pseudorhus* and *Premna lignum-vitae* (see **Appendix 2**).

Green divided birds into three groups, dispersers, fruit thieves and seed predators, and concluded that Lewin's honeyeaters, pied currawongs and topknot pigeons were potentially important dispersers in all habitats. The former two species occur widely through the vine thicket communities (see **Appendix 8**), as well as the olive-backed oriole, which is a seasonally important disperser. Green also noted that some bird species such as honeyeaters and bowerbirds varied between plants in their roles as dispersers, thieves or predators, swallowing and dispersing small fruits but pecking the flesh and dropping the seeds of larger fruit. Parrots are generally seed predators, as are some fruit-pigeon species including the emerald dove and the wonga pigeon (Floyd 1990).

Green considered fruit bats to be predominantly fruit thieves because they typically drop seeds and fruit under food trees, but Eby (1995) considered that their mobility and nomadic habit would contribute to significant movement of genetic material between fragmented habits such as remnant rainforest patches. Roosts (camps) of fruit bats were noted during fieldwork at Brigalow Research Station (1987) and upper Zamia Creek (1992).

Larger fruit (e.g. *Owenia venosa*, *Planchonella cotinifolia* and *Pleiogynium timorense*) may be dispersed by emus, which have been recorded in vine thicket on the Rundle Range near the central Queensland coast. They are known to disperse the seed of *Planchonella pohlmaniana* (N. Kershaw pers. comm).