

CHAPTER 5 RESULTS: FLORISTICS, STRUCTURE AND CLASSIFICATION OF RAINFOREST IN SOUTHERN NEW SOUTH WALES

5.1 Introduction

This chapter and the next present results of the study, interpretation and discussion being treated separately in Chapter 7. Results from the total 231 analyses form the basis of the rainforest description, and are presented in Section 5.3. Results of different sampling and analysis methods are presented separately in Chapter 6. A list of sampled plots, with map references, elevation, geology, geography, available phosphorous and community-type is presented in Appendix 5.

5.2 Geographical Extent

Rainforest in southern New South Wales is restricted to patches which are scattered over a wide range of environmental conditions. Fragmented patches are spread over the strip of land between the coast and escarpment, with a bias towards areas of marked topographic relief (Appendices 1 and 2). Mapping from aerial photography suggested that the dominant factor controlling presence of an island of rainforest vegetation surrounded by sclerophyll forest is topographic shelter. Most patches are situated on the lower southeast-facing slopes of sheltered gullies. The size of patches increases with altitude, but reduces with increasing latitude, so the southern gradsect has many more small patches (see Section 4.2.2).

5.3 Rainforest Types

5.3.1 Introduction

Although the classification was agglomerative, for ease of interpretation the dendrogram (presented in Appendix 3) will be discussed divisively. Groups will be described in terms of dominant canopy trees to facilitate description and communication, but note that the sites were classified on the basis of all vascular species. Such emphasis on the tree stratum is acceptable because it contains the bulk of the biomass, and because of the influence of the canopy on the environment and species composition (Webb et al. 1967b). It is important to be aware of the one dimensional limitation of a dendrogram. Each division can be seen as a mobile, with its two groups able to rotate into other dimensions or to be reversed. The relationship of a subgroup to an adjacent subgroup from a different group may therefore not necessarily be reflected by their proximity on the dendrogram. Thus, for presentation purposes the single outlier site 124 has been moved from the right end to the left end. The small subgroup 5a in community-type 5 has been swung from the right of the successional subgroup to the left of the warm temperate/subtropical one. The warm temperate/subtropical subgroups without and with Ceratopetalum apetalum have also been rotated. There is a danger in interpreting proximity across the dendrogram as significant and the dendrogram must therefore be interpreted in conjunction with the ordination to understand the real relationships between groups.

The dendrogram has been interpreted down to the 79 group level, with some community-types being delimited by the 55 level, but others at higher levels. Species assemblages recur throughout the area and can be grouped to form the rainforest community-types depicted in the dendrogram site groupings of the quantitative classification (Appendix 3). The sites fall into 16 groups in three main categories - high altitude cool to warm temperate, low altitude warm temperate to subtropical and low altitude dry and successional. There are two small successional and dry outlier groups containing only Clyde gradsect sites as well as one single site high altitude outlier. Table 9 lists the rainforest types produced by the numerical classification and their equivalents in Australian rainforest classification systems.

The following is an outline of the three major classification groups. Detailed description of these and their component subgroups is presented later in this chapter. Although the bulk of the chapter is long and detailed, this information on composition of rainforest communities is an important component of the present study results, and was therefore considered a necessary part of this thesis. Care must be taken in extrapolation of information from the lower dendrogram levels because of the role of chance in determining differences between sites.

Cool and warm temperate forests

After the two outlier groups the next separation is between the high altitude Eucryphia moorei, Doryphora sassafras

TABLE 9. Rainforest types and their equivalents in other classifications

Community- type	Climatic- type	Baur 1957	Webb's 1959 structural types	Webb and Tracey's 1981 Ecofloristic provinces	Floyd 1982 ('subformations')	Walker and Hopkins (in press)	N.S.W. Forestry Commission 1981
1	CT	?(Nothofagus) alliance	MMF, MFF	A2	CT	Simple microphyll tall closed fern (or moss) Eucryphia forest	CT
2	CT/WT	?	NFF	A2	CT/WT	Simple microphyll-notophyll tall closed (fern?) Eucryphia- Doryphora forest	?
3	WT	(Ceratopetalum), Doryphora association	SNVFF	A3	WT	Simple notophyll tall closed Doryphora-Acmena forest	WT
4	WT	?	SNVF	A3	WT	Simple notophyll tall closed (vine?) Acmena forest	WT
5	WT/ST)))))	(Ceratopetalum), (Schizomeria) association or Schizomeria, Doryphora, (Ackama), Cryptocarya association	NVF	A1	WT/ST	Complex notophyll mixed tall closed forest	?
6	WT/ST))))		CNVF	A1	WT/ST	Complex notophyll mixed tall closed forest	?
7	WT/LITT.	?	NVF	A2	LITT/WT	Simple-complex notophyll mixed tall closed forest	?
8	WT	Ceratopetalum, Doryphora association	NVF	A3	WT	Simple-complex notophyll mixed tall closed forest	WT

cont.

TABLE 9 - Page 2

Community- type	Climatic- type	Baur 1957	Webb's 1959 structural types	Webb and Tracey's 1981 Ecofloristic provinces	Floyd 1982 ('subformations')	Walker and Hopkins (in press)	N.S.W. Forestry Commission 1981
9	WT	Ceratopetalum, Doryphora association	NVF	A3	WT	Simple notophyll tall closed Ceratopetalum forest	WT
10	ST/WT	Ceratopetalum, Diploglottis association	CNVF	A1	WT/ST	Complex notophyll-mesophyll mixed tall closed forest (with feather palms)	?
11	WT	?	NVF	A3	WT	Simple notophyll tall closed Ceratopetalum-Backhousia forest	WT
12	Dry	?	SNVF	A1	Dry	Simple notophyll tall closed Backhousia forest	Dry
13	WT/ST (successional)	?	SNVF-NVF	A1	WT/ST	Simple-complex notophyll mixed tall closed forest	?
14	WT/ST (successional)	?	SNVF-NVF	A1	WT/ST	Simple-complex notophyll mid-high closed mixed forest	?
15	Dry	?	SNVF	A1	Dry	Simple notophyll tall closed Backhousia forest	Dry
16	WT/ST (successional)	?	NVF	A3	WT	Simple notophyll mid-high closed Ceratopetalum-Backhousia forest	?

and Acmena smithii-dominated groups (200 to 1050 m) and all lower altitude groups (0 to 450 m). The left hand group comprises predominantly medium to high altitude sites. Within this group the main subdivision is between high and medium altitudes. The high altitude subgroup is then divided into the highest altitude cool temperate and the lower cool temperate/warm temperate community-types. The medium altitude subgroup divides into a community-type with, and one without, D. sassafras.

Both high and medium altitude subgroups include sites from both gradsects, which are mainly located inland, but also in intermediate to coastal areas where elevation is adequate. They include five geological types, the other four only occurring in the coastal area of the Clyde gradsect, where elevation is insufficient for development of these forests.

Warm temperate, subtropical and littoral forests

In the large lower altitude group of the right side of the dendrogram, one small outlier group separates at a high level. This consists of four species-poor warm temperate/subtropical successional sites. The next division is between relatively undisturbed warm temperate/subtropical sites mainly from the Clyde gradsect between zero and 400 m altitude, and dry rainforest and successional warm temperate forest between 50 and 450 m mainly from the Dromedary gradsect.

The warm temperate/subtropical group comprises the most floristically rich and structurally complex sites. Within this group a small outlier of three sites separates at a high level,

but the main subdivision in the group separates a warm temperate/subtropical subgroup without Ceratopetalum apetalum from warm temperate/littoral, warm temperate, and subtropical/warm temperate sites which predominantly contain C. apetalum.

The warm temperate/subtropical subgroup without Ceratopetalum apetalum is characterized by Citronella moorei and Dendrocide excelsa. It includes one intermediate in richness, coastal Dromedary community-type and one very rich Clyde non-coastal type.

The second major warm temperate/subtropical subgroup separates into an intermediate richness warm temperate/littoral community-type and a subgroup of rich community-types containing Ceratopetalum apetalum. The C. apetalum subgroup includes one community-type of successional sites and a group of three of mature rainforest. The first mature type, at medium to low altitude, is strongly C. apetalum-dominated, while the second, at lower altitudes, is less so. The third community-type is coastal and at very low altitudes. Here C. apetalum is codominant with numerous tree species, and the palm Archontophoenix cunninghamiana is characteristic.

Dry and successional forests

The major right-hand Dromedary gradsect group splits first into a subgroup of dry rainforest and one of successional sites. In the left-hand subgroup (and community-type) are three 'communities' (in a broad sense) dominated by Bacchousia myrtifolia with decreasing amounts of Acmena smithii. These

sites are located at lower altitudes than the right-hand successional subgroup which is floristically richer. The latter can be divided into two community-types, type 13 being less disturbed than the lower-canopied type 14.

5.3.2 Cool and warm temperate rainforest

Community-type 1: Cool Temperate (MMF and MFF - see Appendix 3)

Community-type 1 (Table 10) is characterized by a group of high altitude species, dominated by the tree species Eucryphia moorei. Four other tree species were recorded as infrequent - Doryphora sassafras, Acacia melanoxylon, Hedycarya angustifolia and Elaeocarpus holopetalus. Only one shrub (Coprosma quadrifida) was recorded as frequent, with tree ferns, in particular Dicksonia antarctica dominating the understorey. Seven species of ground ferns and six of epiphytic ferns were frequent. Angiosperm epiphytes are only represented by Fieldia australis and Sarcochilus falcatus, and vines are not very conspicuous and only represented by slender individuals of Pandorea pandorana, Smilax australis, Clematis aristata and Parsonsia brownii. Four herbs are common but inconspicuous. A complete absence of sedges, grasses and palms was recorded but bryophytes are abundant. Community-type 1 occurs between 550 and 1050 m altitude and has three subgroups or 'communities' (in the broad sense). It occurs mainly in the inland section of the Clyde gradsect, and on a number of geological types.

The first community comprises solely site 124, the highest altitude site of the survey (Plate 6). This site on the

Table 10 Cool - warm temperate community-types (from 231 site quantitative dendrogram)

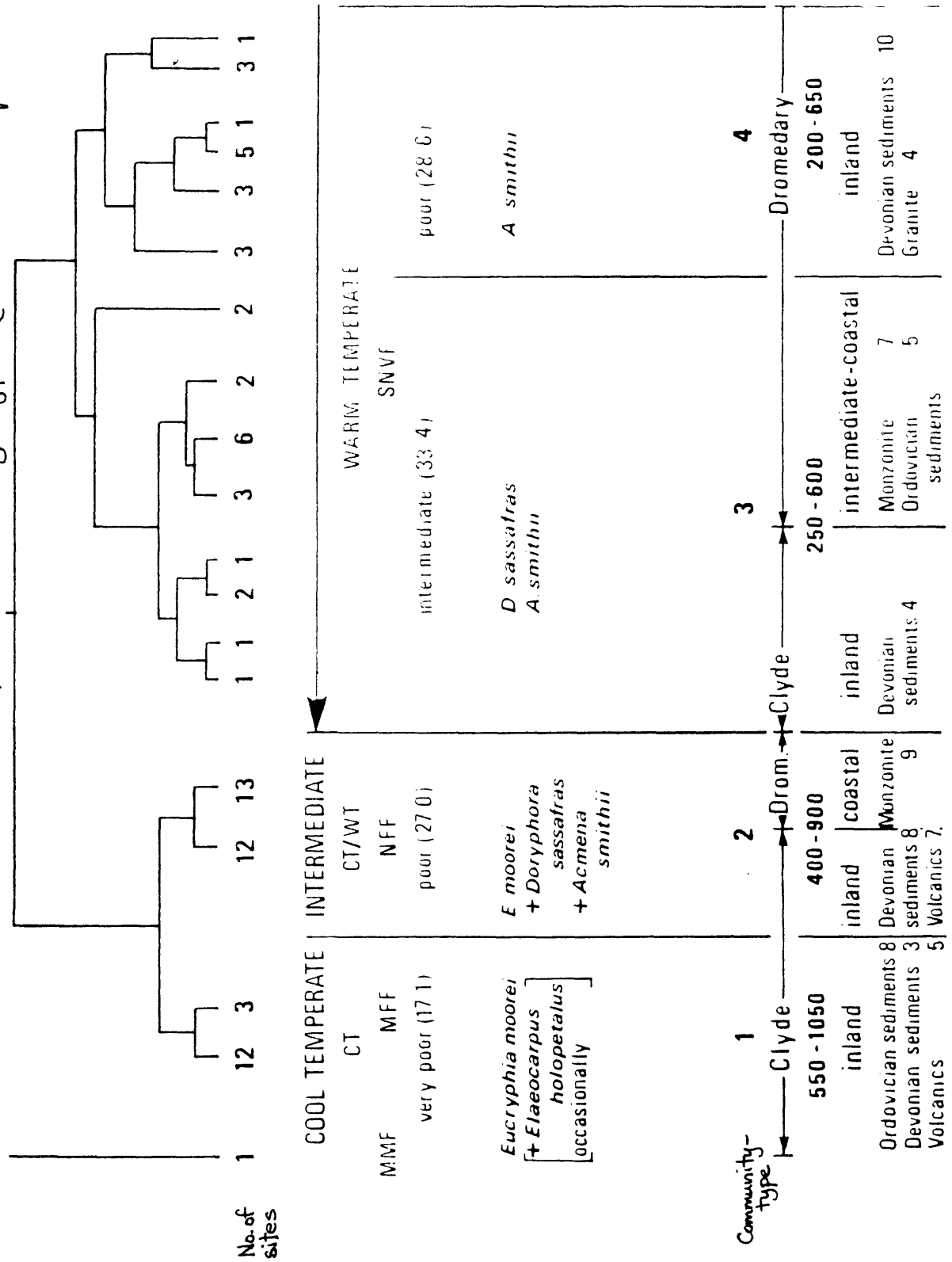




Plate 6. Microphyll mossy forest above 1000 m on Mt Budawang, showing abundance of bryophytes.



Plate 7. Microphyll fern forest dominated by *Eucryphia moorei* with an understorey of *Dicksonia antarctica*, Monga State Forest.

south of Mount Budawang is an outlier instead of fusing with its near neighbour 123 as was expected. The reason for this was elucidated by examination of the fusion table and calculation of similarities (Table 21). This examination is presented here because it illustrates well the importance of understanding the analysis methods adopted. The first fusion in the highest altitude group was between 123 and 73, the latter being the highest site in the northeast gullies of Mount Budawang (but nearly 200 m lower than site 123), and floristically poor (in terms of vascular species). Following this narrow preference by 123 for fusion with site 73 over site 124 the latter, which is very species-poor moves progressively further away from 123 as the high altitude group grows with successive fusions. Site 124 with only eleven vascular species, has the lowest species number of all plots surveyed, followed by site 123 with 13, then site 184 with 16. However sites 124 and 123 were found to be very rich in bryophyte species (see Section 5.4.2). As well as being very low in species richness site 124 is different in having Elaeocarpus holopetalus as a common canopy tree, although Eucryphia moorei is dominant. Site 123 also has E. holopetalus, but in smaller numbers. The Eucryphia moorei-Elaeocarpus holopetalus community was thus recorded at very high altitudes in the inland section of the Clyde gradsect, on Devonian sediments. The sites are very damp and the ground, rocks and trees are swathed in bryophytes, with many ground and tree ferns also present.

TABLE 21. Analysis of floristic relationships
between sites 73, 123 and 124

(a) Abundance (0-3), Presence or absence (✓/x)

(b) Difference in score^φ from site 123 - quantitative/binary

Species	(a)						Status	(b)					
	Site 73	Site 123	Site 124					Site 73	Site 123	Site 124			
<u>Callicoma serratifolia</u>	1	✓	0	x	0	x	\$	1	1	0	0	0	0
<u>Smilax australis</u>	1	✓	0	x	0	x	\$	1	1	0	0	0	0
<u>Doryphora sassafras</u>	1	✓	0	x	0	x	\$	1	1	0	0	0	0
<u>Microsorium scandens</u>	1	✓	0	x	0	x	\$	1	1	0	0	0	0
<u>Pyrrosia rupestris</u>	2	✓	3	✓	0	x	+	1	0	0	3	1	1
<u>Tasmania lanceolata</u>	0	x	0	x	1	✓	\$	0	0	0	1	1	1
<u>Blechnum pattersonii</u>	2	✓	0	x	0	x	\$	2	1	0	0	0	0
<u>Dicksonia antarctica</u>	3	✓	3	✓	3	✓	*	0	0	0	0	0	0
<u>Fieldia australis</u>	3	✓	3	✓	1	✓	*	0	0	0	2	0	0
<u>Lastreopsis acuminata</u>	2	✓	3	✓	0	x	+	1	0	0	3	1	1
<u>Eucryphia moorei</u>	3	✓	3	✓	3	✓	*	0	0	0	0	0	0
<u>Polyphlebium venosum</u>	3	✓	3	✓	0	x	+	0	0	0	3	1	1
<u>Microsorium diversifolium</u>	2	✓	3	✓	3	✓	*	1	0	0	0	0	0
<u>Blechnum wattsi</u>	3	✓	3	✓	3	✓	*	0	0	0	0	0	0
<u>Parsonsia brownii</u>	2	✓	3	✓	2	✓	*	1	0	0	1	0	0
<u>Hymenophyllum</u>													
<u>cupressiforme</u>	0	x	1	✓	1	✓	x	1	1	0	0	0	0
<u>Asplenium bulbiferum</u>	1	✓	0	x	0	x	\$	1	1	0	0	0	0
<u>Elaeocarpus holopetalus</u>	0	x	1	✓	2	✓	x	1	1	0	1	0	0
<u>Grammitis billardieri</u>	1	✓	3	✓	3	✓	*	2	0	0	0	0	0
<u>Hymenophyllum flabellatum</u>	1	✓	1	✓	2	✓	*	0	0	0	1	0	0
Total species	17	13	11										
Total differences excluding double zeros								8	2		14	3	
Total differences including double zeros								15	8		15	4	

φ Taking site 123's score as zero, others were calculated as being different by 1, 2 or 3 points, or as zero if the same as 123.

Status legend

- * Common to all sites
- + Present only in 73 and 123
- x Present only in 123 and 124
- \$ Present only in one of the three sites (i.e. a double absence).

TABLE 21 - Page 2

SUMMARY

	Site comparisons		
	123/73	123/124	73/124
Number of species present in the first site, but not in the second	2	3	9
Number absent in the first site, but present in the second	6	1	3
Number of double presences	11	10	8
Number of double absences	1	6	0

The second and third communities in community-type 1 are represented by 15 sites at high altitudes, in which Eucryphia moorei forms a monospecific canopy and Dicksonia antarctica forms a closed, but discontinuous tree fern layer (Plate 7). The forest floor is very open with occasional ground ferns on bare litter. The second community is further subdivided just below the dendrogram cut-off level in Appendix 3 to separate a group of three Dromedary gradsect sites of upper Paddy's Creek, from the Clyde sites. These three sites have higher representation of the ferns Asplenium bulbiferum and Histiopteris incisa but lack Grammitis billardieri and only one has the filmy fern Hymenophyllum flabellatum which is common in the other sites of the second community. The southern gradsect sites are on Ordovician sediments and intermediate in geography, while the northern ones are also on Ordovician sediments or on Devonian sediments but inland.

The third community in the Eucryphia moorei-dominated community-type consists of three sites in the headwaters of Currowan Creek of the Clyde gradsect. This is a slightly lower high altitude subgroup on Devonian volcanics which lacks the fern Blechnum wattsii and the vine Parsonsia brownii as well as Hymenophyllum flabellatum. The shrub Coprosma quadrifida is more common here than in the other sites.

Community-type 2: Cool/Warm Temperate (NFF)

Community-type 2 is relatively poor in species richness, but characterized by the combination of high altitude species with increasing numbers of generalist species. It has higher total tree (11), shrub (6), ground fern (13) and epiphytic fern (10) species than community-type 1. Eucryphia moorei together with Doryphora sassafras dominates these forests, with Acmena smithii subdominant, and several other tree species may be present. The angiosperm epiphytes Dendrobium pugioniforme and Sarcochilus falcatus are common, the latter being at its best development for the study in this community-type. Epiphytic bryophytes, though still very abundant, are not as conspicuous as at higher altitudes. A distinct tree fern understorey of Dicksonia antarctica characterizes these forests, but some understorey shrub species are also frequent. Ground fern species are numerous and angiosperm epiphytes common. Vines, although not a conspicuous component, include numerous species. Herbs are inconspicuous and few in species, and sedges, grasses and palms are absent. The forest floor is generally open with deep litter and scattered ferns.

The main reductions in species from community-type 1 to 2 are in frequencies of the fern Blechnum wattsii and the vine Parsonsia brownii, which occur here with their lower altitude counterpart species. Vines play a more important role in this community-type than in the first, with six frequent species and eight infrequent ones, occasionally occurring as large individuals. This community-type has representatives in both gradsects and all three geographic zones at altitudes between 400 and 900 m, on Devonian sediments and volcanics, and on monzonite.

Community-type 2 breaks into two communities, the first comprising solely sites from the northern gradsect and the second predominantly from the southern gradsect. An obvious difference between the two is that the northern one contains Tasmannia insipida and Elatostema reticulata which do not extend as far south as the second gradsect (see Table 15). A second difference is that the Dromedary community contains geographically 'coastal' species such as Citriobatus pauciflorus at high altitudes on Mount Dromedary, which would not extend inland to where the high altitude forests occur in the northern gradsect. The small tree Synoum glandulosum similarly occurs in the second community, that is, at high altitude sites only when they are located in the coastal section of the southern gradsect.

Community-type 3: Warm Temperate (SNVFF) - D. sassafras/A. smithii

The main difference between community-type complexes 3/4 and 1/2 is in increasing numbers of generalist species and decreasing numbers of high altitude species, and these trends are

TABLE 15. Species reaching distributional limits in or near the study area

Species	Status	Previous limit	New limit	Author
<u>Acacia silvestris</u>	N E+			
<u>Acmena smithii</u>	+			
<u>Acronychia oblongifolia</u>	+			
<u>Alectryon subcinereus</u>	+			
<u>Alphitonia excelsa</u>	S	Mt. Dromedary		
<u>Aphanopetalum resinosum</u>	S *	Twofold Bay		
<u>Archontophoenix cunninghamiana</u>	S	Pebbly Beach, Murrumerang N.P.	Newton's Beach, Nadgee N.R.	
<u>Arthropteris tenella</u>	S	Bunga Head, Mimosa Rocks N.P.		
<u>Asplenium australasicum</u>	S	Bunga Head, Mimosa Rocks N.P.		
<u>Astrotricha latifolia</u>	S	Tuross River		
<u>Backhousia myrtifolia</u>	S O	Bermagui	Wapengo Creek, Mumbulla S.F.	Floyd
<u>Baeckea virgata</u>	+			
<u>Baloghia lucida</u>	S	Mt. Dromedary		
<u>Bedfordia arborescens</u>	N			
<u>Beyeria lasiocarpa</u>	+			
<u>Breynia oblongifolia</u>	S *	Merrimbula	Jane Spiers Beach, Nadgee N.R.	
<u>Bulbophyllum exiguum</u>	S	Mt. Dromedary		
<u>Callicoma serratifolia</u>	S *	Sugarloaf Mtn, Budawang N.P.	Durras Lake	
<u>Celastrus australis</u>	+			
<u>Ceratopetalum apetalum</u>	S	Bateman's Bay		
<u>Cissus antarctica</u>	S *O	Beecroft Peninsula	(Mt. Dromedary) Tathra	Paris
<u>Cissus hypoglauca</u>	+			
<u>Citriobatus pauciflorus</u>	S O	Mount Dromedary	Bunga Head, Mimosa Rocks N.P.	Binns, Floyd
<u>Citronella moorei</u>	S *	Clyde Mtn	Goodenough Gully, Araluen	
<u>Claoxylon australe</u>	S O	Bermagui	Bunga Head, Mimosa Rocks N.P.	Floyd
<u>Clerodendrum tomentosum</u>	S *O	Illawarra	(London Foundation, Kioloa)	
			Oakey Beach, Murrumerang N.P.	Floyd
<u>Commersonia fraseri</u>	S	Pambula		

cont.

TABLE 15 - Page 2

Species	Status	Previous limit	New limit	Author
<u>Cryptocarya glaucescens</u>	S *	London Foundation, Kioloa	Mt. Dromedary	
<u>Cryptocarya microneura</u>	S *	London Foundation, Kioloa	Bolaro Mtn, Buckenbowra S.F.	
<u>Cyathea cooperi</u>	S *	Beecroft Peninsula	Durras Mtn, Murrumerang N.P.	
<u>Cyathea leichhardtiana</u>	+			
<u>Cymbidium suave</u>	S	Merrimbula		
<u>Dendrobium pugioniforme</u>	S	Mumbulla Mtn		
<u>Dendrobium speciosum</u>	+			
<u>Dendrobium linguiforme</u>	+			
<u>Dendrocnide excelsa</u>	S	Bega		
<u>Dianella laevis</u>	S			
<u>Diospyros australis</u>	S *	Turtle Trail, Buckenbowra S.F.	Bolaro Mtn, Buckenbowra S.F.	
<u>Diospyros pentamera</u>	S *	Beecroft Peninsula	Pebbly Beach, Murrumerang N.P.	
<u>Diploglottis australis</u>	S *	Jamberoo, Illawarra	Durras Mtn, Kioloa S.F.	
<u>Doryphora sassafras</u>	S	Bega district		
<u>Ehretia acuminata</u>	S	Bega		
<u>Elaeocarpus holopetalus</u>	+	Barrington Tops to East Gippsland		
<u>Elaeodendron australe</u>	S	Oakey Beach, Murrumerang N.P.		
<u>Emmenosperma alphitonioides</u>	S *	Illawarra	Leechey Flat, Clyde Mtn	
<u>Endiandra sieberi</u>	S *	Beecroft Peninsula	Pebbly Beach, Murrumerang N.P.	
<u>Eriostemon trachyphyllus</u>	E+			
<u>Eucriphia moorei</u>	N E+	Wollongong area to Howe Range, East Gippsland		
<u>Eupomatia laurina</u>	+			
<u>Eustrephus latifolius</u>	+			
<u>Ficus coronata</u>	+			
<u>Ficus obliqua</u>	S	Mt. Dromedary		
<u>Ficus rubiginosa</u>	S	Mt. Dromedary		
	0		Bellbird Creek, Eden	Floyd, Binns

cont.

TABLE 15 - Page 3

Species	Status	Previous limit	New limit	Author
<u>Geitonoplesium cymosum</u>	+			
<u>Glochidion ferdinandii</u>	S 0	Ulladulla	Oakey Beach, Murramarang N.P.	Preece
<u>Guioa semiglauc</u>	S *	Milton	Big Bit Hill, Boyne S.F.	
<u>Hibbertia scandens</u>	S *	Narooma	Mt. Dromedary	
<u>Howittia trilocularis</u>	+			
<u>Lantana camara</u>	S	Bega		
<u>Libertia paniculata</u>	+			
<u>Liparis reflexa</u>	S	Quartpot Creek, Bolaro S.F.	Myrtle Creek, Wadbilliga N.P.	
<u>Livistona australis</u>	+			
<u>Macrozamia communis</u>	S			
<u>Malaisia scandens</u>	S	Mt. Dromedary		
<u>Marsdenia rostrata</u>	+			
<u>Marsdenia flavescens</u>	+			
<u>Melodinus australis</u>	S *	Illawarra	Cockwhy Creek, South Brooman S.F.	
<u>Morinda jasminoides</u>	+			
<u>Myoporum acuminatum</u>	S 0	Bermagui	Bunga Head, Mimosa Rocks N.P.	Floyd
<u>Notolaea longifolia</u>	S *0	Bateman's Bay	(Mt. Dromedary)	Floyd
<u>Olearia argophylla</u>	N	Bulli	Runga Head, Mimosa Rocks N.P.	
<u>Omolanthus populifolius</u>	+			
<u>Palmeria scandens</u>	S	Bateman's Bay		
<u>Parsonsia straminea</u>	S	Mt. Dromedary		
<u>Passiflora edulis</u>	S *	Illawarra	Nadgee N.R.	
<u>Passiflora herbertiana</u>	S	Narooma		
<u>Pennantia cunninghamiana</u>	S *0	Milton	Leechey Creek, Currowan S.F.	Floyd
<u>Pimelea axiflora</u>	N		Musgrave Creek, Budawang N.P.	
<u>Piper novae-hollandiae</u>	S	Mt. Dromedary		

cont.

TABLE 15 - Page 4

Species	Status	Previous limit	New limit	Author
<u>Pittosporum revolutum</u>	+			
<u>Platycerium bifurcatum</u>	S	Bunga Head, Mimosa Rocks N.P.		
<u>Plectorrhiza tridentatum</u>	+			
<u>Polyosma cunninghamii</u>	S *	Kiama	Pebbly Beach, Murrumerang N.P.	
<u>Polyscias murrayi</u>	+			
<u>Pomaderris cinerea</u>	NSE			
<u>Pratia purpurascens</u>	+			
<u>Prostanthera incana</u>	S			
<u>Pseuderanthemum variabile</u>	S	Kianga Creek, Bodalla S.F.		
<u>Psychotria loniceroides</u>	S *0	Dampier S.F. (Narooma)	(Mt. Dromedary) Wapenge Creek, Mumbulla S.F. Mt. Budawang, Budawang N.P. Durras Mtn) Richmond Beach) Murrumerang N.P. Oakley Beach)	Floyd, Binns
<u>Quintinia sieberi</u>	S *	Conjola		
<u>Rhodamnia rubescens</u>	S *0	London Foundation, Kioloa		
<u>Ripogonum album</u>	+			
<u>Rubus hillii</u>	+			
<u>Rubus moorei</u>	S *0	Bateman's Bay	Bumbo Creek, Dampier S.F.	
<u>Rubus rosifolius</u>	+			
<u>Sambucus australasica</u>	+			
<u>Sarcochilus falcatus</u>	+			
<u>Sarcochilus hillii</u>	+			
<u>Sarcochilus olivaceus</u>	S			
<u>Sarcomelicope simplicifolia</u>	S *	Shoalhaven River	Mt. Dromedary	
<u>Sarcopetalum harveyanum</u>	+			
<u>Schizomeria ovata</u>	S	Mt. Dromedary		
<u>Smilax australis</u>	+			
<u>Smilax glycyphylla</u>	S *	Termeil	Bumbo Creek, Dampier S.F.	

TABLE 15 - Page 5

Species	Status	Previous limit	New limit	Author
<u>Solanum brownii</u>	S	Mt. Dromedary		
<u>Solanum mauritianum</u>	S	Yatteyattah, Milton	Mogo	Mills
<u>Solanum pungetium</u>	+			
<u>Solanum stelligerum</u>	S	Bermagui		
<u>Stenocarpus salignus</u>	S *	Milton	Durras Mtn, Kioloa S.F.	
<u>Stephania japonica</u>	S	Twofold Bay		
<u>Symplocas cochinchinensis</u>	+	Snowy River, Victoria		
<u>Synoum glandulosum</u>	S	Bega		
<u>Tasmannia insipida</u>	S *	Clyde Mtn	Bumbo Creek, Dampier S.F.	
<u>Polyscias sambucifolius</u>	+			
<u>Trema aspera</u>	+			
<u>Tristaniopsis laurina</u>	+			
<u>Tylophora barbata</u>	+			
<u>Zieria smithii</u>	+			

Legend: N = reaches northern limit in southern N.S.W.
 S = reaches southern limit in southern N.S.W. (south of Milton)
 E = endemic to southern N.S.W. - East Gippsland
 + = southern limit in East Gippsland
 * = range extended by present survey
 O = range extended by other workers during current survey period
 () = extension by survey superseded by others during survey.

repeated between community-types 3 and 4. Community-type 3 is found between 250 and 600 m altitude, both inland on Devonian sediments of the Clyde gradsect, and intermediate and coastal on Ordovician sediments and monzonite of the Dromedary gradsect, being dependent on relief created by mountainous terrain. It is richer in species than community-types 1 and 2, and dominated by Doryphora sassafras and Acmena smithii, with a total of 15 frequent tree species. Herb and ground fern species are more common than in the higher community-types, with 10 and 15 species respectively. Frequent epiphytic ferns have been reduced to eight in this community-type, compared to ten in type 2, but angiosperm epiphytes are again three. Vines are characteristic of this community-type, with 15 frequent species, many of which grow larger (robust lianes) than the higher altitude vines. Sedges and palms begin to appear at these altitudes, but in small numbers. Although the tree fern species number is the same as the higher types, density of tree ferns is reduced, with no distinct layer evident, sometimes as occasional clumps but generally scattered. Understorey density varies, often with dense ground ferns and herbs (in very wet or open parts), but occasionally fairly open exposed litter.

Within community-type 3 a subgroup separates early. These two sites at just under 600 m (which is a high altitude for this altitude zone) on the northern side of Mount Dromedary contain fewer of the generalist species, but more of the high altitude ferns such as Asplenium bulbiferum, Histiopteris incisa and Hymenophyllum flabellatum. Acmena smithii is uncommon here,

but common in all other sites of the community-type. Although of fairly high altitude these two sites are exposed and warm because of their northerly aspect, and were observed to be in a stage of succession following disturbance by fire. They lack many of the fern species of the other sites and have more disturbed site indicators such as Acacia implexa and sedges.

The remaining sites in community-type 3 are subdivided into Clyde gradsect or Dromedary gradsect sites, which are floristically differentiated mainly by the absence in the southern gradsect of northern species, which either do not reach that gradsect (e.g. Rubus moorei, Tasmannia insipida and Citronella moorei) or are near their limit and rare there (e.g. Cryptocarya glaucescens, Ripogonum album and Cissus antarctica). In contrast the northern gradsect sites of this community-type have these species, but lack Asplenium australasicum, Ficus coronata, Blechnum cartilagineum, Livistona australis and Psychotria loniceroides. The Clyde subgroup is on Devonian sediments and its inland location may be important in limiting these species, while the Dromedary one is on monzonite or Ordovician sediments and intermediate to coastal.

Within the Clyde subgroup a further subdivision separates the two highest altitude sites (about 600 m) from others. These two contain more of the higher altitude species than any others in this community-type. They then divide into separate communities because of minor species differences such as absence of a number of herbs and shrubs from site 117 and reduced ferns and vines in site 42, but also absence of Eucryphia moorei

and the wet sclerophyll small trees Olearia argophylla and Pomaderris aspera. Site 117 is a more exposed northerly site and appeared to be in a successional state. The second (lower altitude) subgroup of Clyde sites contains three sites on Devonian sediments.

Within the Dromedary subgroup sites 187 and 197 separate from the other nine sites to form a community of disturbed sites, with four extra herb species such as Sigesbeckia orientalis and Hydrocotyle sp. The remaining sites are relatively undisturbed Acmena smithii and Doryphora sassafras-dominated forest, with more ground ferns (e.g. Dennstaedtia davallioides) and the epiphytic fern species Pyrrosia rupestris. Three of these sites at lower altitude, on monzonite and more recently disturbed, form a separate community with some species at the top of their altitudinal range (Claoxylon australe, Plectranthus parvifolius and Backhousia myrtifolia). The six higher altitude sites form a community without these species, but they include the epiphytic filmy fern Polyphlebium venosum which rarely occurs below this altitude.

Community-type 4: Warm Temperate (SNVF) - A. smithii

Community-type 4 differs from type 3 in being comparatively species-poor and in particular in having fewer of the high altitude species and a complete lack of Doryphora sassafras and the small tree Synoum glandulosum (which is generally common elsewhere except at very high altitudes), and very few epiphytic ferns. Dominated by Acmena smithii, it

comprises many disturbed sites such as site 221 (Plate 8), which are often low and vine-tangled, sometimes with abundant ground ferns. It has fewer frequent tree (8), ground fern (13) and epiphytic fern (2), vine (12) and herb species (7). Smaller reductions occur in angiosperm epiphytes (2) and palms are rare. This community-type is found only in the Dromedary gradsect, where it is mainly inland, (with only three sites in the intermediate zone) and on Devonian sediments and granite between 200 and 650 m. It has more lower altitude sites than community-type 3.

The first separation forms a generally higher altitude subgroup on granite as opposed to the majority of sites in altitude zones 3 and 2 on Devonian volcanics and two sites on Ordovician sediments. This higher altitude group is also geographically discrete, containing the furthest inland sites (between Wadbilliga River crossing and Conways Gap, where the Wadbilliga Road climbs up to the tablelands). It contains two sites at altitude 4 and one at altitude 3, all on granite, but also one at altitude 2 on Devonian sediments. In contrast the majority of other sites in this community-type are located on Devonian sediments and at two separate inland locations, and also appear to have been subjected to more recent disturbance. The smaller, higher and less disturbed subgroup lacks a number of vine species (Aphanopetalum resinosum, Marsdenia flavescens, Celastrus australis) and the shrubs Hymenanthera dentata and Claoxylon australe. This subgroup is then divided into its low altitude site (221) and a community of three higher sites.



Plate 8. Simple notophyll vine forest of community-type 4 in Wadbillige National Park, dominated by Acmena smithii with abundant vines.



Plate 9. Large individual of Dendrocnide excelsa (Giant Stinging Tree) in complex notophyll vine forest of community-type 6, Budawang National Park.

The latter group has the three wet sclerophyll species Olearia argophylla, Bedfordia arborescens and Pomaderris aspera plus the high altitude epiphytic fern Microsorium diversifolium. The low altitude community is very open simple vine forest. The minor differences between the communities of the major subgroup in community-type 4 may be attributed to minor local environmental differences or chance dispersal factors.

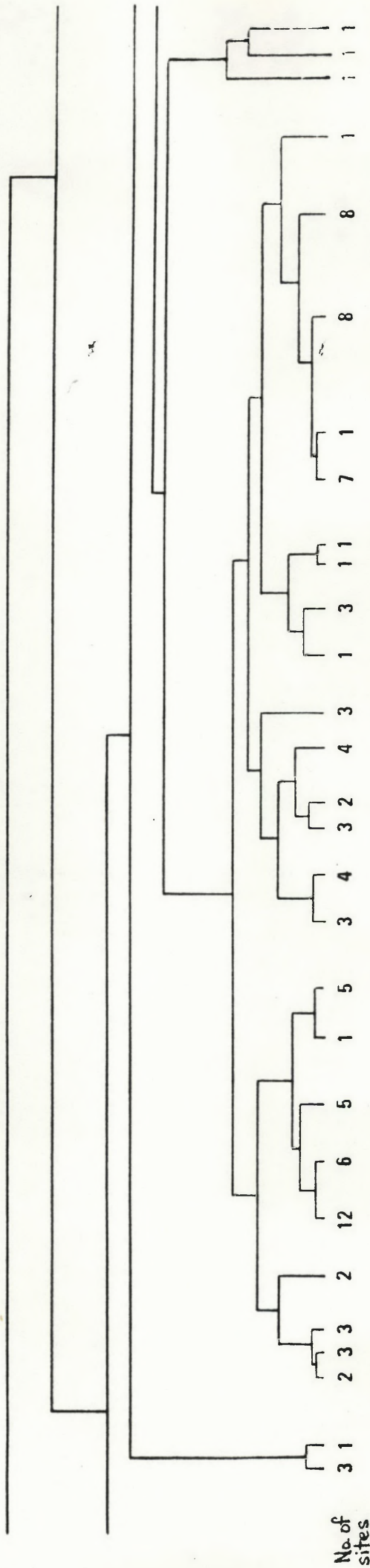
5.3.3 Warm temperate, subtropical and littoral rainforest

Community-type 5: Warm Temperate/Subtropical (NVF)

Moving from the high altitude left side of the dendrogram, the first low altitude community-type is 5 which is restricted to the coastal zone of the southern gradsect (Table 11). This type comprises a series of relatively mature communities as well as successional disturbed ones around Mount Dromedary between altitudes 50 and 350 m on monzonite. It is formed from two classification groups, one being an outlier of the total low altitude sites. Acmena smithii, Doryphora sassafras, Dendrocnide excelsa and Baloghia lucida are the characteristic trees of the less disturbed sites, but only the latter two species characterize the more disturbed ones. Vines are particularly prominent in this community-type and the ground fern cover is generally dense.

This community-type is intermediate in species richness with more frequent tree (13), epiphytic fern (5) and vine (17) species than community-type 4 but fewer shrub (6) and ground fern (9) species. However, infrequent shrub and fern

Table II Warm temperate - subtropical community-types (from 231 quantitative dendrogram)



167

WARM TEMPERATE - SUB-TROPICAL

community-type	WARM TEMPERATE / SUB-TROPICAL			WT/LITTORAL			WARM TEMPERATE			ST/WT		WT	
	NVF	CNVF	NVF	NVF	NVF	NVF	NVF	NVF	CNVF - two parts, rich (38-2)	species rich (38-0)	NVF	NVF	
	poor (27.5)	intermediate (33.0)	very rich (43.2)	intermediate (35.0)	very rich (41.5)	rich (37.7)	rich (39.5)						
	<i>Dendrocinide excelsa</i> <i>Baloghia lucida</i> + <i>Ehretia acuminata</i> <i>Bauerella simplicifolia</i> successional	<i>A smithii</i> <i>D. saxatilis</i> + <i>D. excelsa</i> <i>Cryptocarya glaucescens</i> <i>Schizomeria ovata</i> <i>F. coronata</i> <i>Livistonia australis</i> + others	<i>A. smithii</i> , <i>D. saxatilis</i> <i>F. coronata</i> + <i>Acrionychia oblongifolia</i> <i>Diospyros australis</i> <i>Glochidion ferdinandii</i> <i>Guioa seniglaucous</i> <i>Elaeodendron australe</i> many successional	<i>A. smithii</i> <i>D. saxatilis</i> <i>Ceratopetalum apetalum</i> <i>Backhousia myrtifolia</i> successional	<i>C. apetalum</i> + <i>D. saxatilis</i> + <i>A. smithii</i>	<i>C. apetalum</i> + <i>D. saxatilis</i> <i>A. smithii</i> <i>C. glaucescens</i> + <i>L. australis</i> + others	<i>C. apetalum</i> <i>D. saxatilis</i> <i>A. smithii</i> <i>Archontophoenix cunninghamiana</i> <i>C. glaucescens</i> + <i>L. australis</i> + others						
	a	b	6	7	8	a	9	b	10	11			
	150-250	50-350	150-400	0-250	0-350	300-400	50-300	50-300	50-100	200-300			
	coastal	inland - intermediate	coastal	coastal	Devonian	intermediate	intermediate	coastal	Basalt-enriched Permian sediments	intermediate			
	Monzonite	12	Devonian sediments 19 Volcanics 8	Permian 4 Cambrian 3 sediments 10	Devonian sediments 3	Ordovician sediments 14	Ordovician sediments 14	Ordovician sediments 14	Basalt-enriched Permian sediments 8	Ordovician sediments 3			

species numbers are higher. Palms and sedges are again infrequent and herbs few. In all life-forms it is floristically poorer than community-type 6, its partner in this dendrogram subgroup. This type includes the shrub Citriobatus pauciflorus which is absent from its neighbour community-type 6 because it is a coastal species. The lower floristic richness of this community-type compared to community-type 6 may result from the lack of a number of subtropical species which do not extend this far south (e.g. Citronella moorei, Palmeria scandens and Cryptocarya microneura) or are rare at this latitude at their southern limit (Schizomeria ovata and C. pauciflorus). The fern Blechnum pattersonii is also absent from this community-type as well as types 4, 13, 14 and 15 and rare in 7, 8 and 12. This species thus occurs mainly in wetter communities.

The outlier group 5a is floristically poorer particularly in tree, ground fern and epiphytic fern species than the main group within community-type 5 and consists of more recently disturbed and successional sites of this community-type. This successional component is generally more northerly in aspect than the other sites. It is characterized by the subtropical trees Baloghia lucida and Sarcomelicope simplicifolia and the alien shrub Lantana camara. Senecio mikanioides is a common herb in the open disturbed areas. Canopy heights tend to be low.

The most obvious differences between the major component (5b) of community-type 5 and the outlier 5a are the codominance of Acmena smithii and Doryphora sassafras with Dendrocnide excelsa and Baloghia lucida in 5b, and the increased

species richness and canopy height. These sites have a more southerly aspect and are less recently disturbed. Two sites separate early into a community of more disturbed sites, one (159) with a very low (eight m) canopy. Both sites are in small rainforest patches in gullies by the highway some distance from Mount Dromedary and adjacent to cleared farming land. The patch containing site 159 has been severely disturbed by clearing and has a track bulldozed through the middle. These sites were not sampled as on monzonite from the original geological mapping, but more recent evidence suggests they, (at least site 159), are on small monzonite outliers. The lower relief around these two sites makes them more exposed to northerly influences and to fire. They have the disturbance indicator Senecio mikanoides, but also the subtropical epiphytic fern Platyserium bifurcatum and vine Piper novae-hollandiae, and are lacking the sheltered forest tree fern Dicksonia antarctica.

The remaining, more sheltered and taller community-type 5 sites split within a short space into three communities of two, three and three sites respectively. The first is characterized by the subtropical species Piper novae-hollandiae, Sarcomelicope simplicifolia and Baloghia lucida, and the absence of the cooler forest Dicksonia antarctica and epiphytic fern Pyrrosia rupestris. This community occurs in the two most northeasterly sites of the major subgroup of this community-type, which would be less sheltered by the Dromedary massif than the others are. The second community in the major southeast gully also contains B. lucida, but along with the third community has more cooler

forest species such as D. antarctica, the epiphytic fern ally Tmesipteris parva and the tree Hedycarya angustifolia. The three sites of the third community are on the lower south side of the mountain and lack the subtropical B. lucida. Thus the proportion of subtropical species seems to relate to northerly influence and proportion of cooler forest species to southerly aspects with shelter from the mountain.

Community-type 6: Warm Temperate/Subtropical (CNVF)

Community-types 5 and 6 together form one subgroup in the warm temperate/subtropical part of the dendrogram and differ from the other subgroup because of the absence of Ceratopetalum apetalum. Type 6 occurs only in the Clyde gradsect, mainly inland at altitude 150 to 400 m on Devonian sediments and volcanics. Community-type 6 is a very rich, structurally complex tall forest type with codominance by many tree species, which has been classified as warm temperate/subtropical complex notophyll vine forest. Although Acmena smithii and Doryphora sassafras occur in all sites, this community-type is characterized by the many large buttressed individuals of Dendrocnide excelsa (Plate 9) and Citronella moorei, (the latter often laden with large specimens of the birds nest fern, Asplenium australasicum (Plate 10)), as well as occasional strangler figs (Ficus obliqua). The many epiphytes (e.g. Microsorium scandens, Sarcochilus olivaceus, Davallia pyxidata, Rumohra adiantiformis) and vines (Piper novae-hollandiae, Malaisia scandens, Morinda jasminoides, Smilax australis, Pandorea pandorana, Marsdenia rostrata, Cissus



Plate 10. *Citronella moorei*, at its southern limit in the area, laden with specimens of the birds nest fern (*Asplenium australasicum*) in complex notophyll vine forest of community-type 6, Budawang National Park.



Plate 11. Veils of the liane *Piper novae-hollandiae* in complex notophyll vine forest, community-type 6, Budawang National Park.

hypoglauca and Aphanopetalum resinsum) are also characteristic. It is rich in fern species and varies in ground cover from dense to sparse. Many subtropical species such as Pennantia cunninghamii, F. obliqua and Piper novae-hollandiae (Plate 11) are present, and the palm Livistona australis is common.

Nineteen tree species are frequent but a total of 34 is present. Apart from community-type 3 it has the highest frequent ground fern species number (15), and after community-type 2 has the highest epiphytic fern species number. Frequently occurring species of angiosperm epiphytes (5) and vines (20) are a great deal higher than in any other community-type. Herb species numbers are high (10) and sedges and palms, although represented by only one species each, are both frequent. Shrub numbers are relatively high. The community-type is noticeably lacking in the high altitude species (Eucryphia moorei, Microsorium diversifolium, Blechnum wattsi and Parsonsia brownii) as well as in the subtropical vine Celastrus australis. It also has only a small number of sites (5) containing C. apetalum which, in contrast, is common in community-types 8, 9 and 10.

The major subgroup in this community-type contains sites with Ceratopetalum apetalum (occasionally), Dendrocnide excelsa and Piper novae-hollandiae, plus numerous ferns and vines. The first division in this type splits off five sites which have a number of wet sclerophyll trees (Bedfordia arborescens, Olearia argophylla and Pomaderris aspera) as well as three additional herbs (Viola hederacea, Sigesbeckia orientalis

and Geranium homeanum) which may indicate a recovery stage from recent disturbance. Most of these sites are in small or fragmented patches and some have much lower canopies than the majority in this community-type. The remaining sites in this subgroup separate into a community of 12 and one of six. In the larger community D. excelsa occurs in all sites, while the smaller one lacks it in several, but has a suite of species which may be associated with less dense canopy (e.g. Oxalis corniculata, Rubus rosifolius, Solanum aviculare, Acacia trachyphloia and Pimelia axiflora). It also has the subtropical tree Emmenosperma alphitonioides (at its southern limit here) and the epiphytic ferns Davallia pyxidata and Rumohra adiantiformis. The larger group has many sites high in Currowan Creek, and geographically separated from the others of this community-type.

The second major subgroup in the community-type contains six sites in lower Musgrave Creek or south of the Clyde Mountain Road, which have no Ceratopetalum apetalum and no Dendrocnide excelsa (except in site 45) as well as lacking Piper novae-hollandiae and a number of other vines and some ferns. They are geographically close to each other but continuous with others in this community-type.

Community-type 7: Warm Temperate/Littoral (NVF)

On the other side of the main warm temperate/subtropical group is a series of community-types, most of which are solely dominated or codominated by Ceratopetalum apetalum. However within this subgroup Community-type 7, which has C. apetalum

present (and not dominant) in only three of the 19 sites is very diverse, with its suite of littoral/subtropical species. Many of the sites show successional development, with dense vines, low canopies and few large trees. Understorey varies from fairly open to dense. This community-type only occurs in the Clyde gradsect at low altitudes (between zero and 250 m in the coastal zone (except for three intermediate zone sites) on Permian, Cambrian and Ordovician sediments. The highest number of tree species (24 frequent, and a total of 37) occurs in this community-type, but it is also very high in ground fern (11) and vine (18) species. It has a high total species richness (110), though the mean number of species per site is only intermediate, indicating a large degree of heterogeneity within the community-type. The community-type inevitably lacks the species which are restricted to the highest altitudes. Community-type 7 is dominated by Acmena smithii, Doryphora sassafras and Ficus coronata, but characterized by Acronychia oblongifolia, Diospyros australis, Glochidion ferdinandii, Guioa semiglaucula and Elaeodendron australe.

The highest division within this community-type forms an outlier group of three sites at Cockwhy Creek, which subjective assessment rated as all obviously different, one (site 64) seeming much drier, simpler and more open and being dominated by Backhousia myrtifolia, and the other two having different degrees of Ceratopetalum apetalum dominance. This community is the only one in the type with C. apetalum, where it is mainly codominant with Doryphora sassafras, but with Acmena smithii also

common. (B. myrtifolia dominates site 64). It is lacking in a number of tree species, which occur in many other sites of the community-type, (particularly Acronychia oblongifolia), and also a number of vines, (in particular Rubus moorei), which is present in all others in the community-type. Canopies are dense and lower than in the other warm temperate and subtropical community-types, and in two sites there are many trees of diameter approximately 35 cm indicating a uniform regeneration process after past disturbance. These two sites (63 and 65) are both adjacent to cleared land in a river valley. Geographic discreteness and local influences including land use history may therefore explain the discreteness of this community.

The major subgroup of community-type 7 contains no Ceratopetalum apetalum. A division of this group forms one large geographically discrete subgroup of seven sites in the south of Kioloa State Forest, which does not contain the littoral tree Guioa semiglaucula which is present in nearly all others sites in the community-type, but is the only community (within the type) to include Platynerium bifurcatum. It also lacks a combination of the trees and vines generally common in the community-type. Further subdivisions within this southern Kioloa subgroup is based on minor species differences which may relate to minor site differences or to chance.

The remaining subgroup first splits off one community of four sites, geographically discrete and located inland of the highway in the south of the gradsect at Big Bit Hill and Tomboye Hill. These sites all lack Asplenium australasicum, the palm

Livistona australis and a number of tree and vine species, but feature Rhodamnia rubescens. They are generally quite disturbed, vine-tangled sites with low canopies and very few large trees, probably because they are located in an intensively logged area. One of the patches had been very recently severely damaged by logging debris. Differences within the final five site subgroup are minor.

Community-type 8: Warm Temperate (NVF) - successional

Within the main right-hand subgroup of the warm temperate/subtropical group the right side comprises a series of subgroups which contain Ceratopetalum apetalum. The first division splits off those in which C. apetalum is not common, to form community-type 8. This community-type comprises fairly dry, open and often badly disturbed sites containing many tree and vine species, but generally low in epiphytes. The canopy is often low and vine-tangled and the forest floor either open and litter-covered or densely fern-covered in lighter parts. It varies in number of littoral species, its two subgroups appearing to be successional to two different community-types (7 and 9), depending on geographic location. Community-type 8 is very rich in species per site (mean 41.5), but less so in total species, either because of its small number of sites or the degree of homogeneity over the type. This community-type occurs only in the Clyde gradsect at lowish altitudes (between zero and 350 m) over all geographic zones mainly on Devonian sediments but also on Permian and Ordovician sediments. It is high in tree

species (19 frequent, and total 30), but low in epiphytic ferns (3 frequent) and angiosperm epiphytes (none frequent but 4 infrequent). The vine flora is moderately rich (total 17 species). Sites are dominated by different combinations of Backhousia myrtifolia, Acmena smithii, Doryphora sassafras and C. apetalum.

The main differences between this and type 7 are the absence of a number of vines (Aphanopetalum resinosum, Stephania japonica and Ripogonum album) and subtropical/littoral trees (e.g. Acronychia oblongifolia, Polyosma cunninghamii and Rhodamnia rubescens). The absence of the tree fern Cyathea leichhardtiana suggests affinity with community-type 7 rather than with type 9. Presence of the trees Callicoma serratifolia and Tristaniaopsis laurina make it more like type 9.

Division of this community-type separates four inland sites, mainly between 200 and 400 m altitude, from the two coastal sites below 200 m. This is reflected by the lack of subtropical/littoral species such as Acronychia oblongifolia, Diospyros australis, Guioa semiglaucula, Elaeodendron australe and Platynerium bifurcatum in the non-coastal sites. Within this non-coastal subgroup the one intermediate geography, very disturbed site (14, dominated by young Backhousia myrtifolia) forms a separate community with the species Pandorea pandorana, Acacia trachyphloia and Astrotricha latifolia present. The other three sites are all inland near Leechey Flat on Devonian sediments and are characterized by the presence of a species group which contains the trees Cryptocarya microneura and

Schizomeria ovata, as well as the vines Cissus antarctica, Rubus moorei and Malaisia scandens. They also have the epiphytic fern Microsorium scandens and a number of other ferns, which are not found in the very disturbed, vine-tangled community of site 14.

Community-type 9: Warm Temperate (NVF) - C. apetalum

The Ceratopetalum apetalum-dominated subgroup separates into two community-types (9 and 10) of different structural complexity, based mainly on presence or absence of the subtropical palm Archontophoenix cunninghamiana which is at its southern limit, and on dominance by C. apetalum being replaced by codominance with a number of tree species. These differences are not as evident in the species lists of the association table as in the field, the classification types naturally differentiating more on abundances than on presence/absence. Community-type 9 does not include A. cunninghamiana except as rare at one site (78), while it is abundant in community-type 10. Both occur only in the Clyde gradsect and are floristically rich. Community-type 9 is mainly in the intermediate zone, between 50 and 400 m altitude and on Ordovician sediments, but type 10 is at the coast at very low altitude (between 50 and 100 m) and on Permian sediments which may have been enriched by the basalt cap of Durras Mountain.

Community-type 9 is a rich warm temperate notophyll vine forest type (Webb), in which degree of dominance by Ceratopetalum apetalum reduces with reducing altitude. Tree ferns, ground ferns and vines are abundant, and epiphytes

(especially Asplenium australasicum) and palms (Livistona australis) are common. The ground is densely fern-covered and tree diameters are uneven. Total tree flora is high (28 species), and total vines (23) and tree ferns (3) are very high. The tree C. apetalum dominates the canopy (Plate 12).

This warm temperate forest type is subdivided into higher and lower altitude communities (in the broad sense). In the higher altitude (300 to 400 m) community 9a Ceratopetalum apetalum is strongly dominant, with Acmena smithii and Doryphora sassafras subdominant. This community features the tree fern Dicksonia antarctica hosting the epiphyte Fieldia australis, and (along with community-type 10) the prickly tree fern Cyathea leichhardtiana. It lacks the littoral Diospyros australis.

The second component (9b) of community-type 9 has eight sites, of which two (78 and 79) are located at low altitude (zero to 200 m) east of Durras Mountain, and the rest at slightly higher altitudes further inland. The former community (9a) is differentiated by the absence of a number of littoral species (Diospyros australis, Guioa semiglauca, Elaeodendron australe) which are present in sites 78 and 79, but also by the reduced dominance by Ceratopetalum apetalum with the presence of other large tree species (such as Citronella moorei, Cryptocarya glaucescens and occasional Dendrocnide excelsa).

Community-type 10: Subtropical/Warm Temperate (CNVF) - palms

In contrast community-type 10 occurs at low altitudes near the coast and on (presumed basalt-enriched) Permian

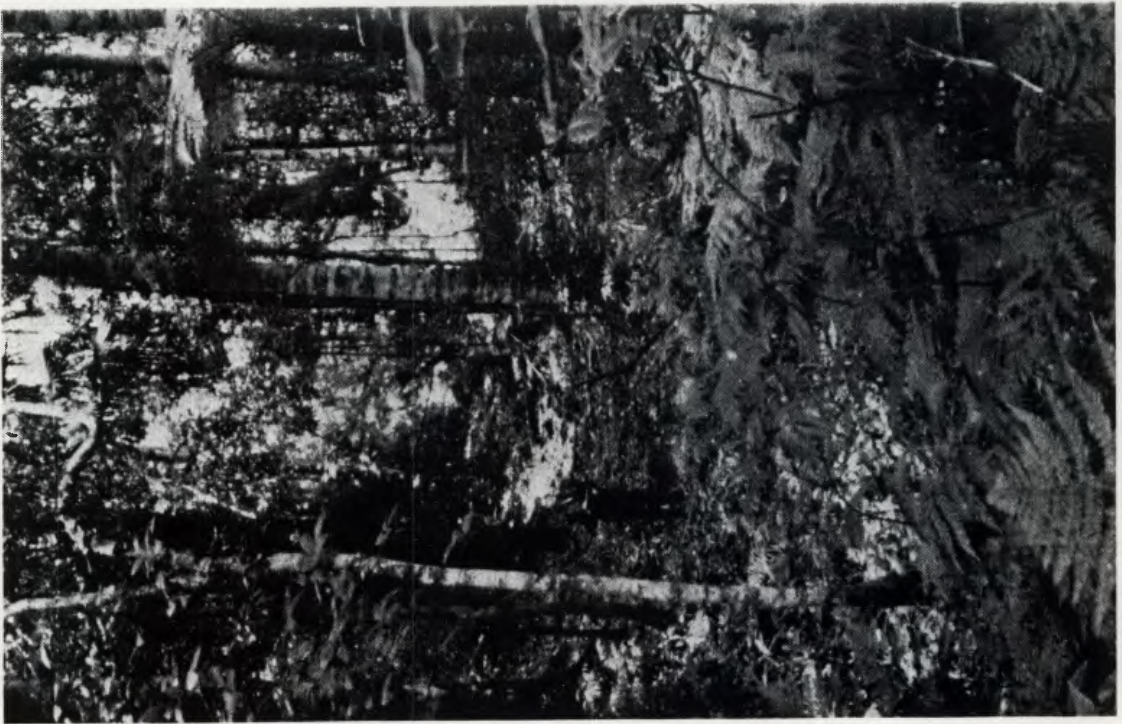


Plate 12. Notophyll vine forest of community-type 9, dominated by coachwood (*Ceratopetalum apetalum*) in Curlew State Forest.



Plate 13. Complex notophyll vine forest of community-type 10, co-dominated by a number of tree species, including the palm *Archontophoenix cunninghamiana* at its southern limit.

sediments. As already described it is partly characterized by codominance by a large number of tree species, although there are fewer total tree species (23) than in type 9. The exclusive presence (and abundance) of the subtropical feather palm Archontophoenix cunninghamiana (Plate 13) as well as presence of a number of other subtropical species such as Diploglottis australis and Diospyros pentamera are also important characteristics of this community-type. In contrast to the warm temperate/subtropical community-type 6, Dendrocide excelsa is completely absent and Citronella moorei rare.

These sites are clustered in gullies predominantly on the west side of Durras Mountain, except for site 82. The latter separates at a higher dendrogram level to form a single site Kioloa community which does not contain A. cunninghamiana and a number of tree species, but is otherwise fairly similar in appearance though less complex. The strangler fig Ficus obliqua, which is mainly restricted to community-type 6, occurs occasionally in the main community, site 25 at Pebbly Beach having the most spectacular specimen found in the survey (Plate 14). The subtropical epiphytic fern Platyserium bifurcatum is the most prominent epiphyte of this community-type, as opposed to Asplenium australasicum in types 9 and 6 (although the latter also appears in this community-type). The subtropical tree Cryptocarya microneura, at its southern limit in this area is present, and some other subtropical and littoral elements such as Diospyros australis and Diospyros pentamera, and Polyosma cunninghamii. Cyathea leichhardtiana is the dominant tree fern.

Plate 14. Impressive above-ground root system of strangler fig (Ficus obliqua) in complex notophyll vine forest, community-type 10, at Murrumerang National Park.



Plate 15. Simple notophyll vine forest of dry rainforest community-type 12, dominated by Backhousia myrtifolia, with little understorey and an open litter-covered floor, Bodalla State Forest.



The forests, although comprising many ground ferns, have large open floor areas. Tree diameters are uneven and these forests have apparently been little disturbed in recent years. With Ceratopetalum apetalum abundant, but codominant with many species, they result from the interaction of soil fertility and altitude. On poorer soils, and at higher altitudes C. apetalum dominates (Section 7.2.1).

Community-type 11: Warm Temperate (NVF) - C. apetalum/

B. myrtifolia/D.sassafras

Community-type 11 separates from the other warm temperate/subtropical types at a high level (as an outlier of 'odd' sites) It consists of only three sites, variable in floristics and structure, in the intermediate to inland area of the Clyde gradsect at low altitudes (200 to 300 m) on Ordovician sediments. They are rich in mean species per site (38) but with a low total tree species (15), low epiphytes, and very low frequent ground fern species (3). However, high (9) infrequent ground ferns indicates heterogeneity between the sites. Generally high altitude and subtropical/littoral species are absent. One site is most similar to community-type 9, while another is more like community-type 12. The third site (125), is dominated by young Ceratopetalum apetalum in succession beneath old eucalypts. This appears to be an invading or re-establishing rainforest. It noticeably lacks the common epiphytes Microsorium scandens and Pyrrosia rupestris. Community-type 11 would therefore need more sites to justify its major community-type status.

5.3.4. Dry and successional rainforest

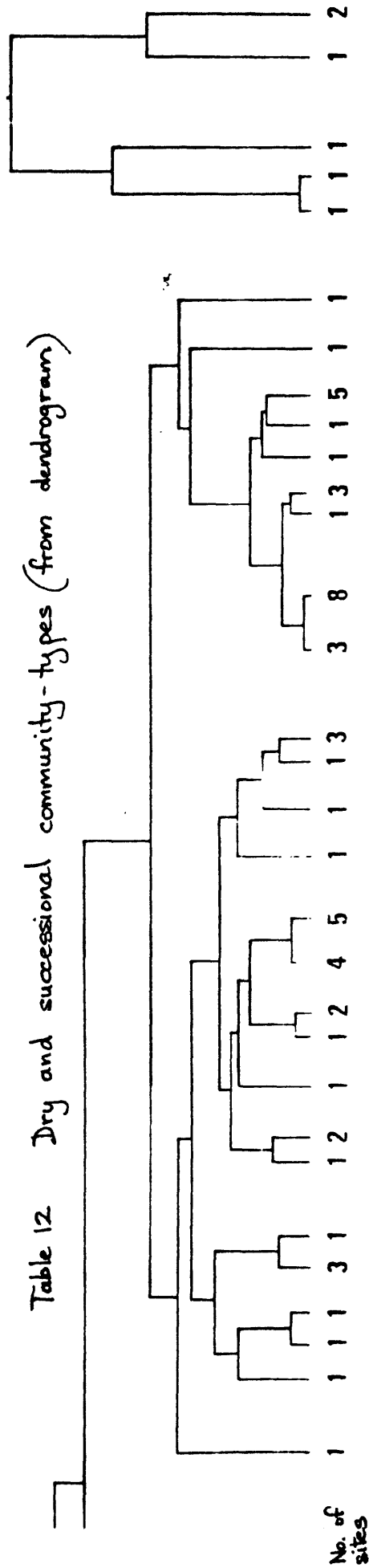
Community-type 12: (SNVF) - B. myrtifolia/A. smithii

Both community-types 12 and 13 (Table 12), comprising mainly sites in the southern gradsect, generally lack high altitude and littoral species and have fewer herb and epiphyte species, plus Ceratopetalum apetalum and the vine Cissus antarctica which do not extend that far south. Community-type 12 is different from community-type 13 in many species, but particularly in having more Backhousia myrtifolia-dominated sites, while lacking many shrubs, vines, herbs and ferns. Community-type 13 has more tree species and is generally found in moister, but more disturbed sites.

Community-type 12 is a composite of many sites dominated mainly by Backhousia myrtifolia, but with different degrees of Acmena smithii and Alectryon subcinereus. It occurs (all except four sites) in the intermediate and coastal zones of the Dromedary gradsect at low altitudes (50 to 300 m) and mainly on Ordovician sediments. This community-type comprises three communities, classified as dry or dry/warm temperate rainforest, (with affinities in the subtropical and warm temperate elements), and floristically poor as well as structurally simple. However, a high degree of heterogeneity is indicated by the very rich total species number (128, being the second highest of all community-types).

The forests are generally very open, with monospecific canopy dominance, shrubs and tree ferns uncommon and epiphytic and ground ferns scattered (Plate 15). The epiphytic fern

Table 12 Dry and successional community-types (from dendrogram)



DRY RAINFOREST AND SUCCESSIONAL SITES

DRY RAINFOREST AND SUCCESSIONAL SITES									
Community-type	SNVF							NVF	
	rich (35.5)	poor (25.0)	poor (29.8)	rich (38.1)	rich (36.0)	poor (24.7)	very (22.7) poor		
	<i>B. myrtifolia</i> <i>A. smithii</i>	<i>B. myrtifolia</i> + <i>A. smithii</i>	<i>B. myrtifolia</i> + <i>A. smithii</i> <i>Alectryon subcinereus</i>	<i>B. myrtifolia</i> <i>A. smithii</i> <i>D. excelsa</i> + others successional	<i>Rapanea howittiana</i> <i>B. lucida</i> <i>Eupomatia laurina</i> <i>Ehretia acuminata</i> successional species	<i>B. myrtifolia</i>	<i>Capetatum</i> + <i>L. australis</i> + <i>B. myrtifolia</i> successional		
	a	12 b	c	13	14	15	16		
	50 - 300 all	50 - 250	50 - 150	100 - 450	400 - 450	50 - 200	50 - 150		
	all	intermediate - coastal	intermediate	inter-inland	inland and coastal	all	all		
	6	15	6	13	1	3	3		
		Ordovician sediments	Ordovician sediments	Ordovician sediments	Monzonite	Ordovician	Ordovician sediments		
				Granite	Devonian				

Asplenium australasicum is present in only one site, while two others (Microsorium diversifolium and M. scandens) are totally absent. Vines are fairly common (although lack the large northern species Celastrus australis and Cissus antarctica) and sedges are locally common. Herbs are also locally common, as is the shrub Eriostemon trachyphyllus, which is virtually restricted to this community-type. Palms are rare. Bryophytes often form a dense covering on tree bases (Plate 17), rocks and logs. Minor floristic differences which contribute to the dendrogram structure are not detectable in the field and environmental correlations are not evident at this level. It is likely that chance or historical factors are involved. A lot of evidence of fire disturbance was observed in and around these sites, with Backhousia myrtifolia showing considerable ability to regenerate by coppicing.

Community-type 12 could alternatively be considered as three main subgroups (Communities 12a, b and c), reflecting gradation from warm temperate/dry to dry rainforest through dominance by Acmena smithii or Backhousia myrtifolia (Table 13). In attempting to separate warm temperate and dry types the cut-off point would be difficult to determine because although 12c has no sites in which Acmena smithii is codominant, it is common in one site and occasional in two. This highlights the problem of local environmental heterogeneity whereby, within a number of rainforest patches, some sites were dominated only by Backhousia myrtifolia and others by both A. smithii and B. myrtifolia (e.g. sites 135, 136 and 137). The chaining within the subgroups, with



Plate 16. The subtropical tree species Diploglottis australis at its southern limit in complex notophyll vine forest of community-type 10 at Durras Mountain, Kioloa State Forest.



Plate 17. Bryophytes are abundant in community-type 12, on trees, rocks and logs.

TABLE 13. Analysis of relative importance of Backhousia myrtifolia and Acmena smithii in community-types 12 and 13

Community	Number of sites	Number of sites for each abundance class						Dominance
		0	1	2	3	4	5	
12a	8	2 (25%)	0	2	4 (50%)	0	0	$\frac{B. \text{ myrtifolia,}}{A. \text{ smithii}}$ (75%)
12b	15	5 (33%)	4	2	4 (27%)	0	0	$\frac{B. \text{ myrtifolia}}{(+ A. \text{ smithii})}$ (93%)
12c	6	3 (50%)	2	1	0 (0%)	0	0	$\frac{B. \text{ myrtifolia}}{}$ (100%)
* 13a	15	6 (40%)	7	2	1 (7%)	0	0	$\frac{B. \text{ myrtifolia}}{+ \text{ others}}$ (100%)
13b	7	0 (0%)	2	1	4 (57%)	4	0	$\frac{A. \text{ smithii}}{+ \text{ others}}$ (28%)

(Figures in brackets are percentage of total sites in community.)

* Additional tree species are abundant in community-type 13, including Dendrocnide excelsa, Baloghia lucida, Alectryon subcinereus.

mainly high level fusions, also shows many sites being grouped together without strong links. Although the possibility of placing the richer (35.5) subgroup into a separate warm temperate/dry type and combining the other two as a dry type was considered, for the above reasons they have all been lumped into one dry rainforest community-type and the three subdivisions classified as 'communities'.

Community 12a - *B. myrtifolia*/*A. smithii*

Within community-type 12 one site (70) in the northern gradsect separates early as it has *Ceratopetalum apetalum* instead of *Acmena smithii*. (In the southern gradsect *A. smithii* replaces *C. apetalum* in simple warm temperate forests.) It has been classified with the next subgroup of seven sites to form community 12a which is mixed warm temperate/dry rainforest dominated by *Backhousia myrtifolia* and/or *A. smithii*. The shrubs *Eupomatia laurina* and *Claoxylon australe* are common in this community but the sedge *Gahnia aspera* is absent (as opposed to 12b and 12c). Minor species differences subdivide the community to the dendrogram cut-off point, possibly reflecting gradsect differences, but possibly also chance dispersal factors.

Community 12a is therefore a rich (35.5 mean species per site) *Backhousia myrtifolia* and *Acmena smithii*-dominated one, with many small differences between sites for which environmental correlations are not clear. It reaches slightly higher altitudes (300 m) than 12b and 12c.

Communities 12b and 12c - *B. myrtifolia*

Backhousia myrtifolia dominates both community 12b and 12c, but they differ in importance of Acmena smithii which occurs as a codominant in four sites of 12b but none of 12c. Although 12c is richer in mean species per site, both communities have the same total species number of 74, indicating species are distributed more evenly through 12c than 12b. The altitude range of 12b is higher (up to 250 m) than 12c (to 150 m).

The difference between these two communities is not readily apparent in floristics and structure in the field as they are both mainly simple open Backhousia myrtifolia-dominated forests with an open litter-covered floor, occasional ferns (commonly Doodia aspera), and locally dense ferns or sedges in lighter areas. Shrubs are few, and vines tend to be of the smaller slender type, although robust individuals do occur occasionally. Floristic differences in the association table (Appendix 6) are small and not easily interpretable in environmental terms. Community 12c, although dominated by Backhousia myrtifolia (Plate 15), is characterized by the smaller tree Alectryon subcinereus and shrub Hymenanthera dentata. Community 12b, on the other hand has the shrubs Citriobatus pauciflorus and Prostanthera incisa, the sedge Leptospermum urophorum and the epiphyte Plectorrhiza tridentata.

Community-type 13: Successional (SNVF) - *B. myrtifolia*/*A. smithii*/*D. excelsa*

Community-type 13 is a combination of Backhousia myrtifolia-dominated and mixed dominant sites, many of which have

a low canopy, vine-tangles and numerous light-demanding species which reflect recent disturbance. This type reaches slightly higher altitudes (450 m) than community-type 12. Community-type 13 has the highest total species number (131) but lower (although still rich) mean species per site. It has the highest number of herb (15) and shrub (14) species and has high numbers of ground ferns (13), and moderately high numbers of epiphytic ferns (4), angiosperm epiphytes (2 frequent but 5 infrequent) and vines (14). In all these life-forms it is more rich than type 12. It has noticeably fewer frequent sedges (1) than community-type 12 and fewer tree species, although tree species numbers are still high.

Community-type 13 occurs solely in the intermediate and inland zones of the Dromedary gradsect between 100 and 450 m altitude on Ordovician sediments and granite. A large number of generalist species occur here in higher frequencies than they do in community-type 12, with many vines, herbs, shrubs and ferns. It is different from type 12 in not having Eriostemon trachyphyllus, the sedge Lepidosperma urophorum, nor a number of other shrubs and the tree species Polyscias murrayi (except for one site, 142). In contrast the vine Marsdenia flavescens is common here. Canopy heights tend to be lower than in type 12 and there is more co-dominance by other tree species (which is probably disturbance-related), e.g. Dendrocide excelsa, Ehretia acuminata, Acronychia oblongifolia, Alectryon subcinereus and Rapanea howittiana. This disturbance influence may also be reflected in the high vine, herb, shrub and fern numbers.

Community-type 13 has only slightly higher total species than type 12, but the considerably higher mean number of species per site indicates generally more frequent species occurrences.

The major division within community-type 13 separates 15 sites which are dominated by Backhousia myrtifolia from seven in which Acmena smithii is more dominant (Table 13). (This problem of local environmental differences has been described in Section 5.3.4 under community-type 12.) In 13a B. myrtifolia dominates with an abundance rating of 3 in all sites, only one site having A. smithii codominant and abundant. A. smithii is generally either absent or rare. In contrast 13b has A. smithii abundant and dominant in four sites, B. myrtifolia abundant in only two and absent in four. This major difference is not evident from the association table, which is based purely on presence, but is obvious in the field.

Community-type 14: Successional (SNVF) - Rapanea howittiana/
Baloghia lucida/Eupomatia laurina/Ehretia
acuminata

Community-type 14 consists of two sites which separate from type 13 at a high level and may be considered as an 'odd' group, therefore not justifying major community-type status. They should be considered as extreme successional relatives of community-types 12 and 13. They are located in very different environments, although both are at medium altitude (400 to 450 m). These two sites have in common the absence of Backhousia myrtifolia and Marsdenia flavescens, as well as Ficus coronata,

which makes them different from community-type 13. They are both in very small, low-canopied successional patches lacking many of the species of the less disturbed rainforest patches. Total species numbers are very poor at only 53, although this could be accounted for by the small site number, as mean number of species per site (36) is rich. The community-type is poor in tree, shrub, ground and epiphytic ferns and vascular epiphytes, but high in herbs and vines.

Community-type 15: Dry (SNVF) - B. myrtifolia

At the right-hand end of the dendrogram are two community-types, 15 and 16, which separate very high, (before the major high/low altitude division) and may therefore be classed as a 'ragbag' group (Goldsmith 1973, quoted by Austin, unpub. lecture notes). They each comprise three sites, all from the Clyde gradsect. These sites nearly all contain Backhousia myrtifolia, Tristaniopsis laurina, Blechnum cartilagineum and Notolaea venosa, but completely lack Acmena smithii and Doryphora sassafras. They in turn separate from each other very high.

Community-type 15 comprises species-poor, simple B. myrtifolia-dominated sites of the northern gradsect, which occur inland and at the coast between 50 and 200 m altitude on Ordovician sediments. They are characterized by high frequency of sedges (with Lomandra longifolia, Lepidosperma laterale and Lepidosperma urophorum), but low frequencies in all other life-forms, particularly vines (Parsonsia straminea being the only frequent one). Total species is very poor at 45, and structure is extremely simple.

Community-type 16: Successional (SNVF) - C. apetalum

Community-type 16 comprises three sites in intermediate and coastal zones between 50 and 150 m in altitude, again on Ordovician sediments. This community-type is the second lowest in species richness (22.7) - following only community-type 1 of the highest altitudes. Two are disturbed successional or expanding (into sclerophyll forest) Ceratopetalum apetalum-dominated sites and one is a successional Backhousia myrtifolia-dominated site, also containing occasional old eucalypt emergents. The community-type is very poor in total species (42) and again low in all life-forms, but higher in vines (6 frequent) than community-type 15. The palm Livistona australis characterizes this type from type 15, as does the fern Culcita dubia. It must be remembered that low total species numbers for these types need to be considered in the light of their small site numbers.

5.4 Floristics

5.4.1 Species lists

The floristic data are based on abundance scores of all vascular species recorded in the 231 plots of the two gradsects, and on presence/absence in patches, as well as presence of bryophytes in the Dromedary gradsect patches. The total species list of 255 vascular plants and 96 bryophytes recorded in the sample as well as additional species recorded in the area is located in Appendix 7. Nomenclature and authors are based on Scott et al. (1976), Costermans (1981), Beadle et al. (1982) and

Scott (1982). Separate species lists for the rainforest types form an association table in Appendix 6. Table 14 documents the number of species in each life-form in each rainforest type.

5.4.2 Regional floristics

Of the 255 vascular species sampled 115 have their southern distributional limits either within the study area (71) or just south of it (44) on the far south coast of New South Wales or in East Gippsland, Victoria. Six species have their northern limits in or near the study area, of which three also have southern limits, and are therefore endemic. In Table 15 these species are listed with their currently known southern limits. Five of them are endemic to this region, therefore also have their northern distributional limits close to the study area. Another three 'southern' species have their northern known limits in the study area.

Of the total 255 species 100 have been classed as "non-rainforest" species as they were found occasionally in rainforest, but more commonly observed in other vegetation types. Many of these are opportunistic 'weedy' species which occur occasionally and only under disturbed canopy. Of these 16 species are at or near their southern limits in the study area.

Of the 155 'rainforest' species, 111 (approximately 70%) are at their southern limit in this region. Excluding the ground fern, herb and sedge components, which contain no species at their southern limits (to the knowledge of the present author), there remain 111 southern limits out of 122 rainforest

TABLE 14. Number of species of each life-form in each community-type - the upper number is for frequent species (i.e. at 3 or more sites) while the lower number is for infrequent species

LIFE FORM	COMMUNITY-TYPE																							
	1	2	3	4	5a	5b	5	6	7	8	9a	9b	9	10	11	12a	12b	12c	12	13	14	15	16	
Trees	1	11	15	8	7	11	13	19	24	19	10	12	15	15	7	10	7	11	16	15	6	6	7	
	4	6	9	14	4	15	1	15	13	11	9	12	13	8	8	13	4	3	17	13	4	5	5	
Shrubs	1	6	7	9	3	3	6	9	6	7	3	5	7	5	4	6	7	8	12	14	4	1	1	
	5	1	3	2	2	4	5	5	6	3	5	2	2	1	8	12	6	8	10	6	4	2	3	
Tree ferns	2	2	2	2	0	2	2	2	1	1	3	1	3	3	2	1	0	1	1	2	1	0	1	
	0	1	0	0	0	0	0	0	1	0	0	2	0	0	2	0	1	1	1	0	0	3	0	
Ground ferns	7	13	15	13	3	9	9	15	11	9	7	8	8	7	3	6	3	6	8	13	6	6	3	
	2	4	4	3	4	5	7	3	4	5	8	3	3	2	9	7	7	6	11	3	2	2	3	
Epiphytic ferns	6	10	8	2	1	4	5	9	5	3	5	4	5	4	2	1	2	1	2	4	3	2	0	
	3	3	3	4	0	3	2	2	0	1	3	1	3	2	2	2	0	0	3	4	1	1	0	

cont.

TABLE 14 - Page 2

LIFE FORM		COMMUNITY-TYPE																						
		1	2	3	4	5a	5b	5	6	7	8	9a	9b	9	10	11	12a	12b	12c	12	13	14	15	16
Vascular		2	3	3	2	0	0	0	5	0	0	2	0	2	0	1	1	0	1	2	2	1	2	0
epiphytes		0	1	1	1	0	3	4	3	1	4	1	1	2	0	3	1	4	1	0	5	0	0	0
Lianes		4	6	15	12	12	13	17	20	18	13	12	15	17	12	9	11	11	11	14	14	11	1	6
		0	8	5	3	5	5	2	3	4	4	6	6	6	5	6	8	1	5	8	3	1	5	7
Herbs		4	4	10	7	5	4	5	10	4	4	0	1	2	1	4	6	6	2	10	15	7	2	0
		4	2	6	4	1	5	4	5	8	3	4	1	3	3	6	9	6	5	3	4	2	3	3
Sedges		0	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	5	3	6	1	0	3	1
		0	0	0	1	0	1	1	0	2	0	0	1	1	1	2	4	3	1	3	3	0	1	1
Palms		0	0	0	0	0	0	0	1	1	1	1	1	1	2	1	0	0	0	0	0	0	0	1
		0	0	1	0	0	1	1	0	0	0	0	1	1	0	0	1	1	0	1	0	0	0	0
Total species		43	81	108	87	47	88	94	127	110	89	79	77	94	71	79	99	74	74	128	131	53	45	42

tree, palm, shrub, vine, tree fern, epiphytic fern and vascular epiphyte species, which is over 90%. This figure highlights the importance of the area in the truncation of the subtropical floristic element. Five localities are particularly prominent in this truncation south of the Murumbidgee, as they contain many of the southern limits (Table 16). The remaining southern limit species are scattered through the area.

Table 16

Just north of the study area:

Beecroft Peninsula, Jervis Bay (C. Helman)	9
Yatheyattah Reserve, Milton (A. Floyd)	9

In study area:

Bateman's Bay area - Durras Mountain	6
- Oakey Beach (A. Floyd)	5
Mount Dromedary	12
Bunga Head, Mimosa Rocks National Park (A. Floyd)	7
TOTAL	48

The present study extended the known southern limit of 25 species, while another seven were extended by other workers during this period, the last one during the write-up stage of this thesis, indicating the rapidly increasing rate of knowledge about this previously little known rainforest flora. Table 17 summarizes the northern and southern limit information.

In the bryophyte flora considerable differences in richness were found between community-types. The richest was the highest altitude community above 1000 m, which showed floristic affinities with the southern bryophyte floras of Victoria and New Zealand (G. Scott pers. comm.).

TABLE 17. Summary of southern species limits

SOUTHERN LIMITS		
Total vascular species sampled:		255
Total "rainforest species":		122
Species AT/NEAR northern limit (of which 3 are		
endemic therefore also at southern limit):	6(3)	
		+
Species NEAR southern limit:	44	
		+
AT	:	71
of which extended by survey:	(29)	
	()	
extended during survey:	(7)	
		118

Thus the present study has contributed significantly to biogeographic information on species associations and distributional limits.

5.5 Structure

Structural description has been included in the community-type inventory in Section 5.3. Table 18 summarizes the structure of the rainforest types subjectively into six main types on the basis of information from the proformas.

It can be seen from this table and the inventory description that the rainforests in the study area harbour a wide range of life-forms and that each rainforest type is characterized by a particular life-form combination, from the bryophyte and fern-dominated high altitude Eucryphia moorei sites to the palm, strangler fig and vine-dominated low altitude sites with their numerous tree species, or the simple Backhousia myrtifolia-dominated dry rainforests. The four major subformations will be described here in terms of structure. Within and between these types the 16 community-types form subgroups, often grading subtly from one group or type to another, which have already been described in Section 5.3.

5.5.1 Cool temperate

The cool temperate forests are characterised by low vascular species numbers. This is mainly evident in the very low tree species numbers (often single), but also in low shrub and herb numbers. The pteridophyte and bryophyte floras are in

TABLE 18. Summary of structural features of rainforest subformations, subjectively based on degree of conspicuousness, abundance and species richness, using structural proforma

Rainforest subformation	Dominants	Robust woody lianes	Strangler figs	Palms	Treeferns	Bryophytes
COOL TEMPERATE (MMF, MFF)	<u>Eucryphia moorei</u>	0	0	0	3	3
COOL/WARM TEMPERATE (NFF)	<u>E. moorei</u> <u>Doryphora sassafras</u> <u>Acmena smithii</u>	0	0	0	2	2
WARM TEMPERATE (SNVF)	<u>Ceratopetalum apetalum</u> <u>D. sassafras</u> <u>A. smithii</u>	2	0	1	2	1
WARM TEMPERATE/ SUBTROPICAL (NVF)	<u>Citronella moorei</u> <u>Dendrocnide excelsa</u> <u>Schizomeria ovata</u>	3	1	2	1	1
SUBTROPICAL/WARM TEMPERATE (CNVF)	<u>C. apetalum</u> <u>Archontophoenix cunninghamiana</u> and many others	3	1	3	1	1
DRY (SNVF)	<u>Backhousia myrtifolia</u>	0	0	0	0	2

contrast well represented. Tree ferns often form a distinct lower canopy layer (Plate 7) and epiphytic ferns and bryophytes are common. Filmy ferns, commonly Polyphlebium venosum and Hymenophyllum flabellatum, cover the tree fern trunks. The highest altitude sites in the study area are swathed in mosses, dominated by Papillaria spp. (Plate 6). These extremely mossy forests are influenced by the cool temperatures and increased moisture from the clouds and mist which often cover Mount Budawang. Lianes are few, inconspicuous and of the thinner types, and palms, strangler figs and buttressed trunks are completely absent, while epiphytic ferns are reduced in size. A characteristic fern flora is evident, with in some cases a grading between two species of the same genus in the warm temperate/cool temperate transition zone, as in the case of Microsorium diversifolium and M. scandens. Cool temperate forest species tend to have small (microphyll) leaves and this is an important component in Webb's (1959, 1968, 1976, 1978a) structural classification. Coppiced trunks were commonly observed in trees of the cool temperate forests and will be discussed in Chapter 7.

5.5.2 Subtropical

The subtropical forests are complex, with their many codominant tree species and numerous other life-forms well developed. Palms characterize this rainforest type and strangler figs, such as the one in Plate 14 are very noticeable, though not abundant. Buttressed trunks occur in the subtropical-warm temperate group, featuring species such as Dendrocnide

excelsa and Citronella moorei. The tree in Plate 9 is the largest (though not the tallest) tree found during the survey, with a diameter of 4.5 m, and is a very large tree even by northern Australian rainforest standards (personal observation). Robust, woody lianes typify these forests. Some lianes such as Piper novae-hollandiae hang in dense veils (Plate 11). Epiphytic ferns are well developed and dominated by the large Asplenium australasicum (Plate 10) and Platynerium bifurcatum. Leaf size in the subtropical forests tends to be large (notophyll) or occasionally very large (mesophyll) as in Diploglottis australis (Plate 16).

5.5.3 Warm temperate

Between the extremes of subtropical and cool temperate rainforests structural and floristic features grade through a range of warm temperate rainforest associations. Intermediate complexity and diversity are found here, with smaller species numbers and various degrees of special life-forms (Tables 14 and 18). Some warm temperate forests are dominated by only one or two tree species, such as Acmena smithii at sites 171 and 172, Doryphora sassafras at sites 17 and 190, Ceratopetalum apetalum and A. smithii at site 82. Others have several codominants, for example all three of these species at site 81. Vines are common but with fewer robust specimens than in the subtropical forests. The epiphytic fern Platynerium bifurcatum and the palm Archontophoenix cunninghamiana are absent. Ferns - tree, ground and epiphytic - are variable in importance, depending on local light and moisture conditions.

5.5.4 Dry and littoral rainforest

Dry rainforest and littoral rainforest belong floristically to the subtropical/warm temperate element. The former is dominated by Backhousia myrtifolia (Plate 15) and is common at lower altitudes in more exposed, drier and probably more disturbed environments. This simple forest type characterically has a monospecific canopy and very reduced understorey and ground layers, giving an open appearance (Plate 15). Special life-forms are limited, represented by few lianes, mainly of the thin and slender types (Webb, Tracey and Williams 1976), some ground ferns and occasional tree ferns, but abundant bryophytes. Bryophytes often form blankets over the bases of trees and on rocks and logs (Plate 17). Epiphytic orchids are sometimes abundant and include five species. In some more protected parts of these forests, such as at gully junctions, Acmena smithii joins B. myrtifolia to co-dominate the canopy, or even replaces it.

Littoral rainforest, in contrast, is rich in tree and vine species but contains fewer bryophyte and fern species. It has denser understorey and ground layers and more palms.

Thus it can be seen that a range of structural characteristics correlates with different rainforest types.

5.6 Floristic Ordination and Environmental Correlations

The ordination was employed to clarify environmental correlations of site groupings (Section 4.4.2). Interpretation was not difficult because no major curvilinearity problems were present. The relationships between the 231 sites are illustrated

by the ordination in Fig. 7 and summarized in Table 19. (Group symbols are allocated at a broad level on the basis of the three major groups of the classification). In Figs 8 and 9 ordination axes 1/2 and 1/3 are presented with group symbols corresponding to the community-types of the classification. Vector 1 correlates with altitude, with high altitude sites at the bottom of the ordination. Vector 2 separates groups on floristic and structural diversity, the low diversity sites being on the left. It may be correlated with a combination of soil moisture and disturbance (particularly by fire), factors which are likely to be closely linked. Vector 3, which is less clear, relates to soil fertility, with a trend towards higher available phosphorus on the right (Fig. 10).

5.6.1 Vector 1

The highest altitude, Eucryphia moorei-dominated sites (community-type 1) form a group at the bottom of the axis. Moving upwards, a group of high to medium altitude E. moorei-Doryphora sassafras-dominated sites (community-type 2) is found, followed by a medium altitude D. sassafras-Acmena smithii group (community-type 3) and an A. smithii (community-type 4) group of medium to low altitude. Effectively the medium to high altitude sites (including all sites containing E. moorei) are thus located in the lower half of the ordination. The upper half of the axis grades from medium-low to low altitude, incorporating three major groups characterized by Backhousia myrtifolia, Ceratopetalum apetalum and A. smithii-D. sassafras-dominated mixtures respectively.

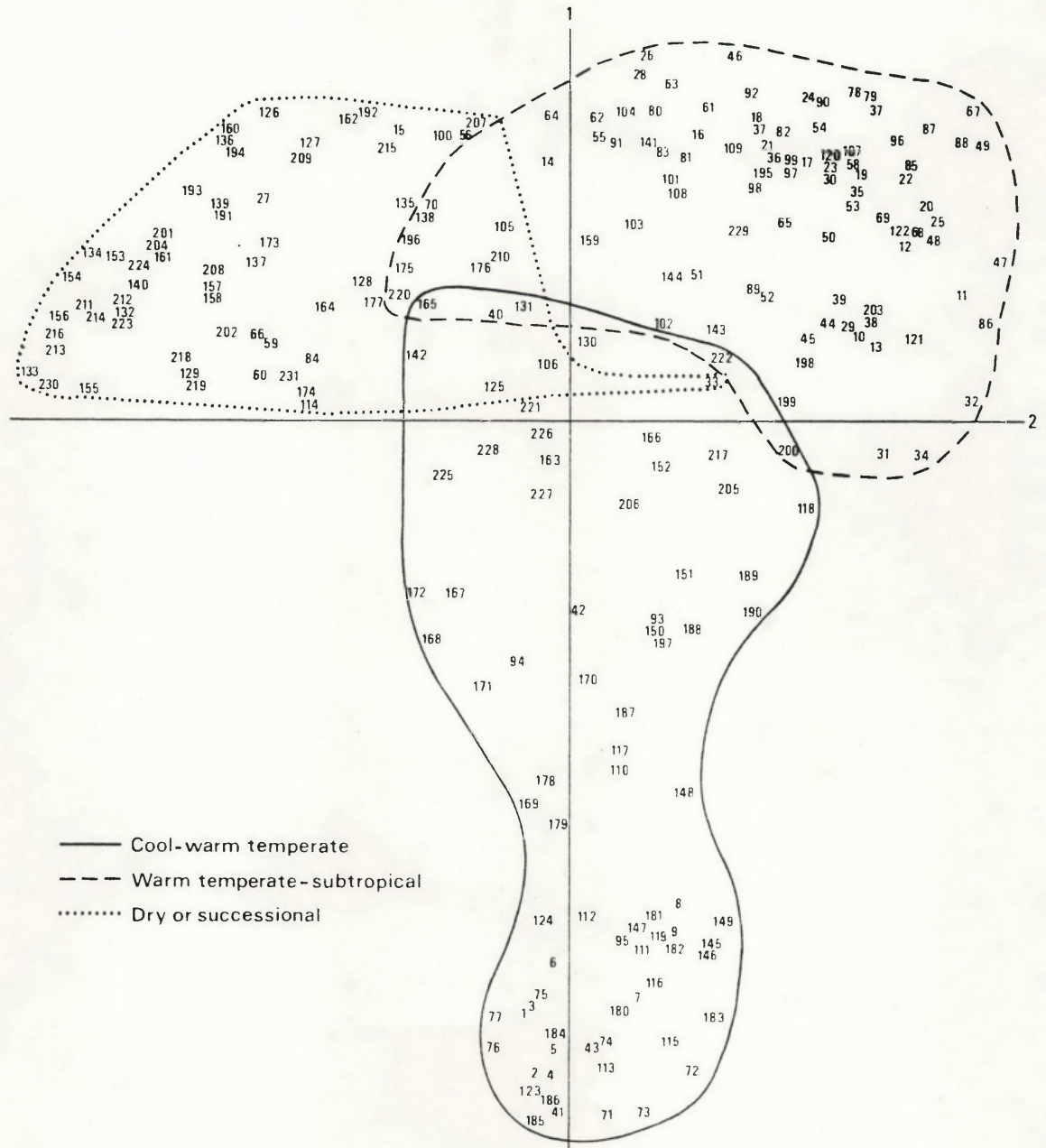


Fig. 7. Site distribution in three major quantitative classification groups on ordination axes 1 and 2.

TABLE 19. Summary of environmental correlations for rainforest subformations, subjectively generalized from ordination results and environmental proforma

Rainforest subformation	Dominants	Altitude	Disturbance	Fertility	Latitude	Geography	Aspect	Topography
COOL TEMPERATE (MMF, MFF)	<u>Eucryphia moorei</u>	high	low	low - high	north	inland	SE	mountainous
					south	coast - intermediate		
COOL/WARM TEMPERATE (NFF)	<u>E. moorei</u> <u>Doryphora sassafras</u> <u>Acmena smithii</u>	intermediate- high	low	low - high	north	inland	SE	mountainous
					south	coast - intermediate		
WARM TEMPERATE (SNVF)	<u>Ceratopetalum apetalum</u> <u>D. sassafras</u>	intermediate- low	moderate	low - inter- mediate	north	intermediate	SE	hilly
					south	all		
WARM TEMPERATE/ SUBTROPICAL (NVF)	<u>Citronella moorei</u> <u>Dendrocnide excelsa</u> <u>Schizomeria ovata</u>	low - intermediate	low - moderate	high	north	inland	SE-N	hilly - mountainous
					south	coast		

cont.

TABLE 19 - Page 2

Rainforest subformation	Dominants	Altitude	Disturbance	Fertility	Latitude	Geography	Aspect	Topography
SUBTROPICAL/ WARM TEMPERATE (CNVF)	<u>C. apetalum</u> <u>Archontophoenix</u> <u>cunninghamiana</u> plus many others	low	low	low	north	coast	SE-NW	hilly
DRY (SNVF)	<u>Backhousia myrtifolia</u>	low	high	low			SE	hilly

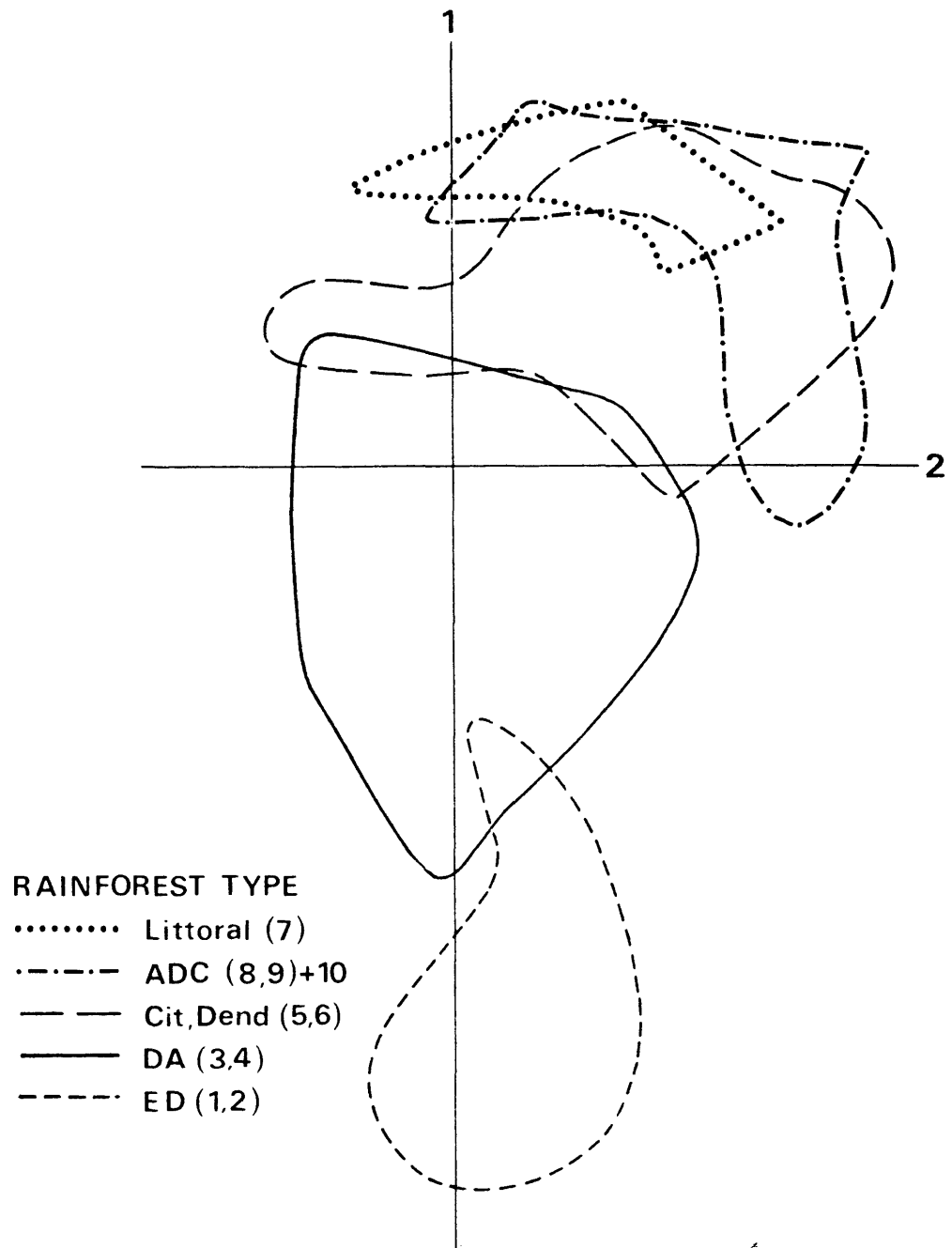


Fig. 8. Distribution of rainforest types on ordination axes 1 and 2 after exclusion of dry and successional types.

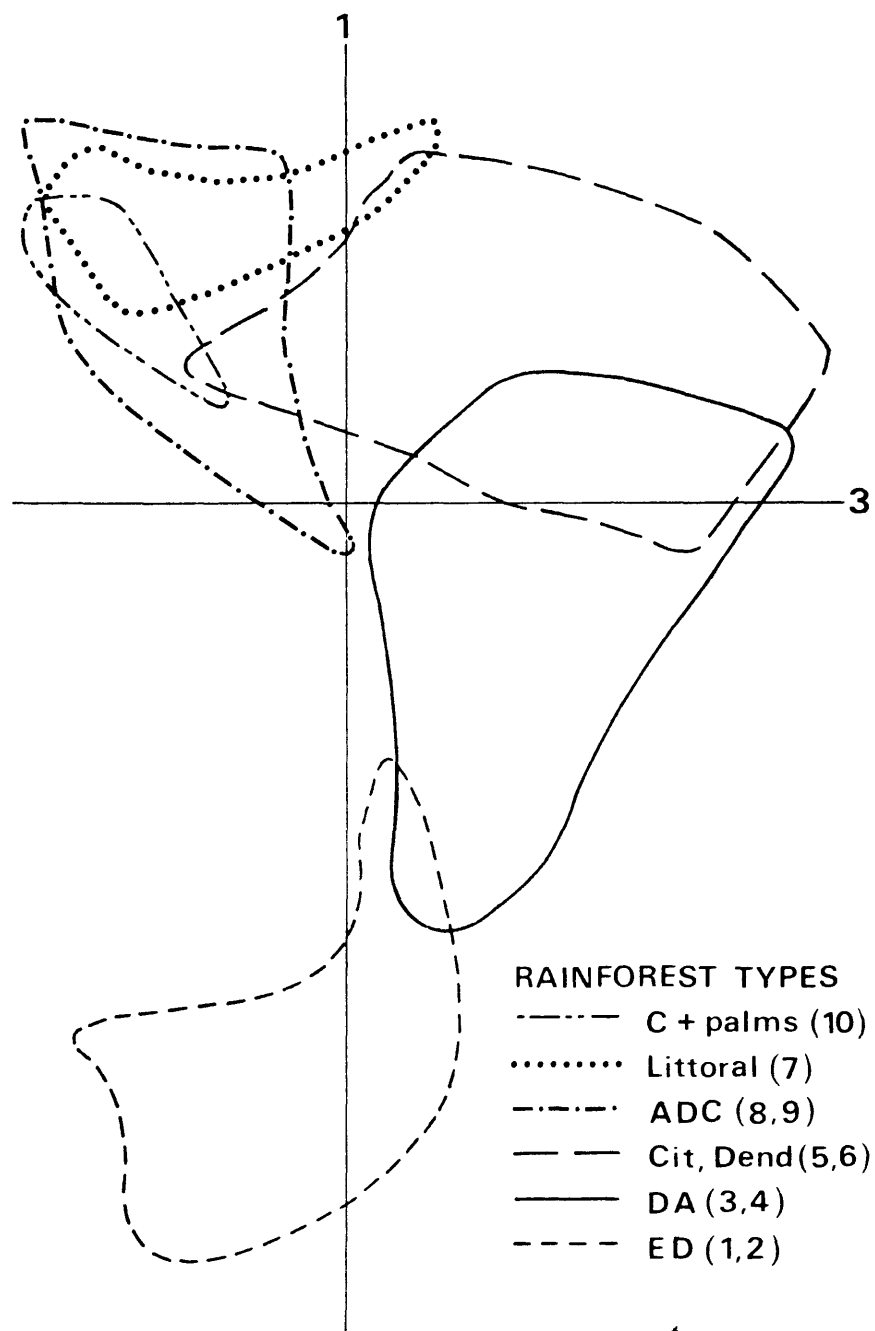


Fig. 9. Distribution of rainforest types on ordination axes 1 and 3 after exclusion of dry and successional types.

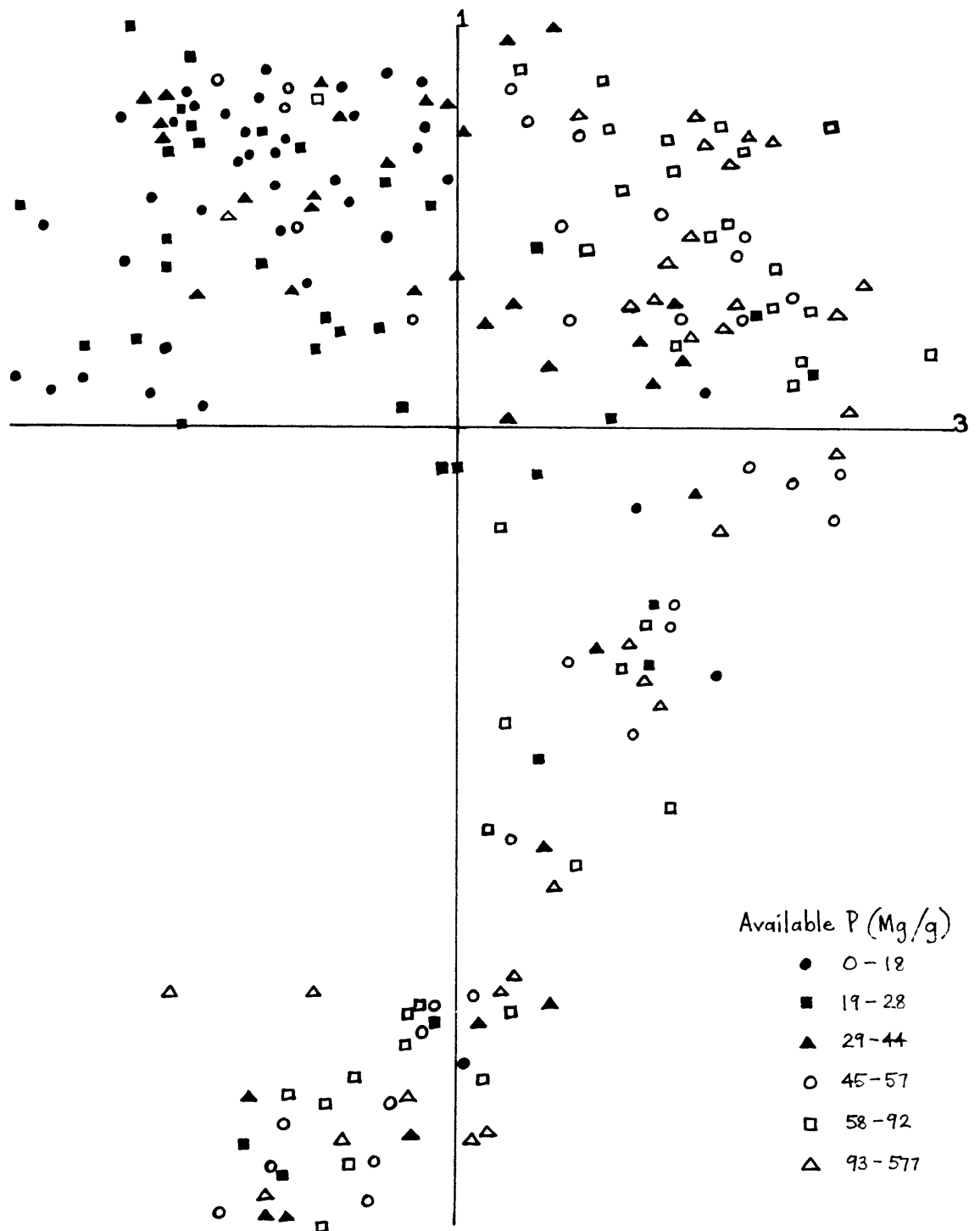


Fig. 10 Available P at sites 1-231 displayed on ordination axes 1 and 3

Within these three aggregated groups, subgroups are separated into very low and low/medium altitudes. Backhousia myrtifolia-dominated sites of community-type 12 at altitude 1 (between zero and 200 m) are found at the top of the ordination and those of community-types 13 and 14 at altitude 2 (200 to 400 m), but also more successional, are closer to the middle.

In a similar altitudinal trend, the community-type 10 Ceratopetalum apetalum-dominated sites from altitude 1 (which are mainly located around Durras Mountain and are floristically rich, with codominance by the palm Archontophoenix cunninghamiana and numerous other tree species) are located high on axis 1 along with the other low altitude C. apetalum-dominated community-types 8 and 9a. In contrast 9b, which occurs only between 300 and 400 m altitude, and type 11 at 200 to 300 m, are located closer to the centre of axis 1.

The Acmena smithii, Doryphora sassafras and littoral species-dominated sites of community-type 7, at very low altitudes (0 to 250 m) lie above the richer low to medium altitude (50 to 400 m) community-types 5 and 6 on axis 1.

Thus the relationships between the major types as well as their component community-types can be clearly seen to relate to altitude along axis 1 (Figs 7 to 9).

5.6.2 Vector 2

Backhousia myrtifolia-dominated and successional sites are clearly separated from all other sites on this vector, and located to the left of the axis (Fig. 7). On the extreme right

side are the two subtropical community-types 6 and 10 and the well-developed Ceratopetalum apetalum-dominated community-type 9. Grading between these minimally disturbed community-types towards the dry and successional ones are the warm temperate-littoral community-type 7, the successional C. apetalum-dominated type 8 and successional Acmena smithii-Doryphora sassafras-dominated type 5. The three sites of outlier type 11 are spread across the centre of axis 2 in proportion to their apparent disturbance differences, the right hand site 33 being a tall C. apetalum-dominated forest suffering wind damage, and the others (125 and 114) young advancing or recovering C. apetalum or B. myrtifolia-dominated forests.

The high to medium altitude sites are not clearly separated into subgroups on this axis, although there is a slight tendency for the very high pure Eucryphia moorei community-type 1 and the low to medium simple Acmena smithii community-type 4 towards the left. These two groups together with the dry and successional ones, and the successional warm temperate type 5a, are on the whole the floristically poorest groups. However, a group of community-types with high species numbers is found in the centre of the axis indicating that the interpretation of this axis is not purely species richness. These community-types are the outlier 11, the warm temperate-littoral type 7 and the successional Ceratopetalum apetalum-dominated type 8.

Thus vector 2 appears to be correlated with site disturbance, which is likely to be linked to soil moisture availability and expressed partly by floristic richness (see Section 7.2.1 fire).

5.6.3 Vector 3

All Ceratopetalum apetalum-dominated types (8, 9, 10 and 11), including low and medium altitude, rich and poor, well-developed and successional sites, join the low altitude Acmena smithii-Doryphora sassafras-dominated littoral type 7, the low altitude Backhousia myrtifolia group on Ordovician sediments, and the low altitude outlier types 15 and 16 on the left side of axis 3 (Fig. 9). On the right are the rich Dendrocnide excelsa, Citronella moorei-dominated type 6 and its related but less well-developed Dromedary gradsect type 5, plus the successional types 13 and 14.

A reason for this separation was indicated by the available phosphorus analysis which showed the right hand side to contain the highest scores (Fig. 10). This vector may thus be linked with geological parent material and soil fertility.

All sites on Permian and Cambrian sediments, and the assumed basalt-enriched (Section 4.2.4) Permian sediments are located to the left along with the majority of Ordovician sediment sites (Fig. 9). In contrast the right side harbours all sites on granites, those on essexite and monzonite, and the majority on the younger sediments of the Upper Devonian, as well as Devonian volcanics. This pattern of more inherently fertile parent material to the right is extremely strong in the upper half of the ordination, but less so in the lower half, suggesting a curvilinearity giving rise to a confounding interaction between geology and altitude, with overriding altitudinal influence at high altitudes (Fig 9). The high to intermediate altitude sites are found on a wide variety of parent materials.

It is interesting to note that the rich subtropical/warm temperate community-type 10 is located on the left despite its assumed soil fertility enrichment and this will be discussed in Section 7.2.1.

Thus the ordination vectors assisted in clarifying environmental correlations of site groupings, to indicate altitude is the major factor, followed by disturbance then soil fertility.

5.6.4 Further analyses

The interaction of altitude, moisture, fertility, disturbance and possibly other factors results in the non-linear distribution of the sites in the ordination, but altitude is clearly the dominant factor. Distinction between the higher altitude cool temperate, cool temperate/warm temperate and warm temperate and the lower altitude warm temperate, subtropical, littoral, dry and successional rainforests dominates the analyses. This confirms field observations and the hypothesis that altitude-related factors have a significant effect on rainforest floristics and structure in this area.

A further analysis, using a subset of low altitude sites only (achieved by masking out the main left-hand dendrogram group), attempted to remove the altitudinal dominance in order to further elucidate other environmental correlations. Backhousia myrtifolia and successional sites separated from other sites on the first axis (as in the original axis 2), while the second axis functioned similarly to the original third axis in separating

sites on fertility as reflected in parent material and available phosphorus. Although the new third axis did not reveal any new substantial correlation, it showed a possible relationship with organic carbon content of soil.

Further masking to remove the major right hand dendrogram group allowed an analysis of the low altitude warm temperate/subtropical/littoral well-developed sites only. It was considered that this removal of both altitudinal and disturbance/soil moisture control over results would provide the opportunity for any other interpretable factors to come to light. This reduced analysis separated sites on axis 1 in the same pattern as the original axis 3 (on fertility), and axis 2 may be related to organic carbon. The only clear distinction on axis 3 is the separation between the Clyde subtropical Citronella moorei and Dendrocnide excelsa-dominated community-type 6 and the Dromedary D. excelsa-dominated group, community-type 5, which had overlapped on all other ordinations. The ecological significance of this may relate to floristic differences based on latitude or parent material. Community-type 6 features C. moorei which does not occur as far south as the Dromedary gradsect. The other difference between the types is that type 6 is on Devonian sediments and volcanics while type 5 is on monzonite.

Fig. 11 and Table 20 show the relationships of some tree species' frequencies to altitude in the Clyde gradsect. Individual species distributions overlap along the altitudinal gradient, although each has a distinctly different distributional pattern. This supports the idea of vegetation as a continuum and

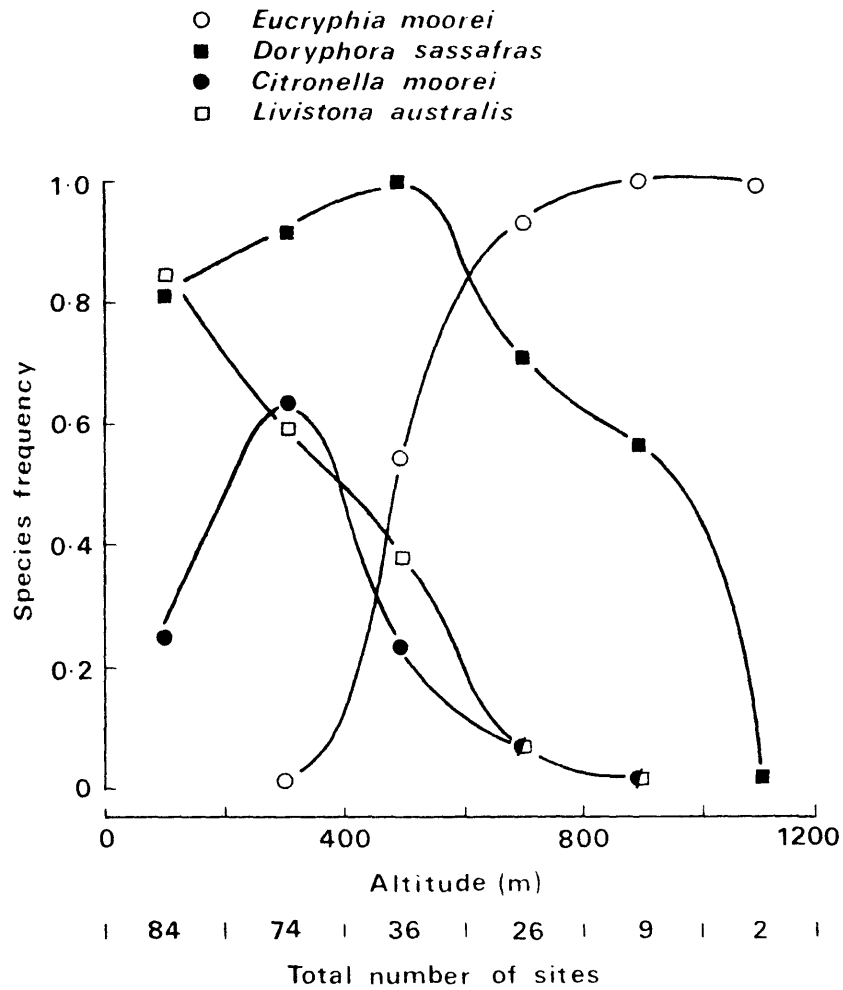


Fig. 11. Relationship to altitude of distribution of selected tree species in the northern gradsect. (Frequency of a species' presence over total sites in each altitude zone — i.e. proportion of sites in which species occurs.)

TABLE 20. Abundance of common tree species at different altitudes in the northern gradsect
 Abundance scale 0-3 (details on following page).

Species	Altitude (in 100 m zones)											
	0-100	101-200	201-300	301-400	401-500	501-600	601-700	701-800	801-900	901-1000	1001-1100	1101-1200
<u>Archontophoenix</u> <u>cunninghamiana</u>	3	3	0	0	0	0	0	0	0	0	0	0
<u>Guioa semiglauc</u>	1	1	0	0	0	0	0	0	0	0	0	0
<u>Backhousia</u> <u>myrtifolia</u>	3	3	3	3	0	0	0	0	0	0	0	0
<u>Ficus species</u>	3	3	3	3	2	2	0	0	0	0	0	0
<u>Ceratopetalum</u> <u>apetalum</u>	3	3	2	2	2	2	0	0	0	0	0	0
<u>Schizomeria ovata</u>	2	2	2	2	1	1	0	0	0	0	0	0
<u>Dendrocnide excelsa</u>	1	1	3	3	3	3	0	0	0	0	0	0
<u>Livistona australis</u>	3	3	1	1	1	1	1	0	0	0	0	0

cont.

TABLE 20 - Page 2

Species	Altitude (in 100 m zones)										
	0-100	101-200	201-300	301-400	401-500	501-600	601-700	701-800	801-900	901-1000	1001-1100 1101-1200
<u>Citronella moorei</u>	1	1	3	3	1	1	1	1	0	0	0
<u>Acmena smithii</u>	3	3	3	3	3	3	2	1	1	0	0
<u>Doryphora sassafras</u>	3	3	3	3	3	3	3	3	2	2	0
<u>Eucryphia moorei</u>	0	0	0	0	2	2	2	2	3	3	3
<u>Atherosperma moschatum</u>	0	0	0	0	0	0	0	0	1	1	0
<u>Elaeocarpus holopetalus</u>	0	0	0	0	0	0	0	0	0	0	1

Abundances (0 - 3) determined from the site data (except for Atherosperma moschatum, which was only recorded outside the gradsect) as the species most common abundance rating in sites of each altitude zone.

illustrates problems, such as intermediate types, associated with attempts to artificially categorize it. Species show a variety of responses to altitude, from the extreme of high altitude restriction by Eucryphia moorei, which mainly occurs above 600 m, to the very low altitudinal restriction for the palm Archontophoenix cunninghamiana and the littoral species Guioa semiglauc, which are only found below 200 m. Between these is a range of different curves, some similar in shape but less marked than those of E. moorei and A. cunninghamiana (e.g. Livistona australis). Others such as Doryphora sassafras and Citronella moorei have more bell-shaped responses as they occur at very low altitudes but peak in the intermediate zone and drop off again above that.

Dendrocide excelsa responds similarly to C. moorei, with very small occurrence below 200 m, an abundance in the 200 to 400 m zone and reducing to 600 m. D. sassafras is the most ubiquitous tree species altitudinally, being common from below 200 m to about 1000 m. E. moorei, although only common above 600 m is found rarely down to about 300 m. Ficus coronata and Schizomeria ovata are abundant below 400 m then drop off rapidly between 400 and 600 m. Backhousia myrtifolia decreases rapidly above 300 m, while Ceratopetalum apetalum decreases fairly evenly between 100 m and 600 m. Acmena smithii is consistently common below 600 m then decreases higher and does not occur above 900 m.

Curves for species over the combined gradsects would give a different picture. Firstly a number of species would not be found in the southern gradsect as explained previously. Some

species such as Eucryphia moorei show a latitudinal/altitudinal shift as the cooler, drier conditions of higher latitudes allow them to descend to lower altitudes than they do further north.

On Mount Dromedary E. moorei was still common at 300 to 400 m and in the Nadgee Nature Reserve of far southern New South Wales it was observed as low as 130 m close to the coast. Reference to rainfall and temperature data (Fig. 2) allows interpretation of this distribution, which will be discussed in Section 7.2.1.

5.6.5 Summary

The results presented in this Chapter show that the study area supports a wide range of rainforest types over a complex range of environments. Altitude is the most important environmental factor, followed by disturbance regime, then soil fertility and latitude.