

A DESCRIPTION OF THE HUON PINE (*LAGAROSTROBOS FRANKLINII* (HOOK. F.) C.J. QUINN) FORESTS OF THE PRINCE OF WALES AND KING BILLY RANGES

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(with two tables and two text-figures)

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The large non-riverine Huon pine forests of the Prince of Wales and King Billy Ranges probably represent glacial refugia. Both are of the implicate rainforest type and both show changes in dominance and species composition of tree and understorey species with altitude. On the Prince of Wales Range, Huon pine dominates the forest over an altitudinal range of 320 m. On the King Billy Range, Huon pine dominates the lower 180 m while the upper 100 m is dominated by King Billy pine. This difference may be due to dispersal rates, geology or climatic preference. The upper slopes of the Prince of Wales Range carry the only known examples of a Huon pine–dwarf leatherwood dominated forest. Both the Prince of Wales and King Billy Ranges are of high conservation and scientific value.

Key Words: Huon pine, King Billy pine, altitude, glacial refugia, Tasmania.

INTRODUCTION

Huon pine (*Lagarostrobos franklinii* (Hook. f.) C.J. Quinn) is a slow-growing endemic gymnosperm largely restricted to the western and southern river systems of Tasmania with a total extent of less than 3000 ha (Gibson 1986). Despite nearly 200 years of exploitation for its superb timber, knowledge of the ecology of this species has been rudimentary until recently (Pedley *et al.* 1980, Davies 1983, Francey *et al.* 1984, Read 1985, Gibson 1986).

Huon pine was apparently more widespread in the past (Colhoun & van de Geer 1986, 1987). It appears to be still expanding its range following amelioration of the climate after the Last Glacial, 10 000–12 000 years ago (Gibson 1986). Despite its slow rate of dispersal from rivers (Gibson 1986), vegetative reproduction is prolific. The species is also highly sensitive to fire and can be eliminated from areas by a single fire event. These features, coupled with frequent high energy flooding of the rivers on which it occurs, largely explain its riverine distribution.

Three large stands (>200 ha) of non-riverine Huon pine occur on the King Billy Range, the Prince of Wales Range and the Teepookana Plateau above the King River. These three stands account for more than 40% of the total extent of Huon pine.

The stands on the Prince of Wales and King Billy Ranges are dominated by the implicate Huon pine rainforest association while the Teepookana stand consists largely of thamnian rainforest communities (Jarman *et al.* 1984, Gibson, unpubl. data). The extent of these stands and the slow spread of Huon pine from river banks indicate that the stands are glacial refugia.

All three stands have been logged to some extent. On the Prince of Wales Range damage has been restricted to a narrow band along the Denison River. The King Billy Range stand has been more heavily logged. Disturbance, however, is very localised due to the highly selective nature of pre-1950 logging operations. The Teepookana Plateau stand has been heavily disturbed by modern logging and roading operations. The aim of the present study is to describe the floristic and altitudinal gradients found on two transects through largely intact Huon pine stands of the Prince of Wales and King Billy Ranges.

STUDY AREAS

The Prince of Wales Range (42°37'S, 145°55'E) is about 14 km NNW of Strathgordon in southwestern Tasmania. The range runs approximately N–S and the eastern side drains into the

Denison River. The entire region is underlain by Precambrian metaquartzites with some Holocene alluvium in the valley (Department of Mines 1975). A section of the eastern side of the range, 4 km above the gorge, has a Huon pine dominated forest from river level (at 120 m) to 440 m a.s.l. Above this forest is extremely thick scrub dominated by *Agastachys odorata* and *Acacia mucronata*, up to the ridge line at 520 m a.s.l.

The King Billy Range (42°35'S, 145°40'E) lies 3 km Sw of the junction of the Gordon and Franklin Rivers. The range is crescent shaped with the main axis running E-W, the arms of the crescent stretch away to the south for about 2 km. The southern slopes drain into the Sprent River. The lower slopes of the range are composed of Precambrian metaquartzites while the upper slopes are of Ordovician siliceous conglomerates, sandstones and siltstones (Department of Mines 1975). Almost the entire southern slopes carry either Huon pine or King Billy pine (*Athrotaxis selaginoides*) dominated rainforests. Huon pine is dominant on the lower slopes from river level (at 140 m) to about 320 m a.s.l. and King Billy pine on the upper slopes from 320 m to the ridgeline at 420 m a.s.l.

Both areas lie within the cold humid climatic zone of Gentilli (1972) and are expected to have rainfalls of the order of 2500 mm (Bureau of Meteorology unpublished data). Both ranges have uniformly steep slopes averaging 50–60% and increasing to 75% for short distances.

METHODS

On the Prince of Wales Range seven subjectively located plots were established from river level to the scrub zone to encompass the floristic variation found over the 330 m altitude of the transect. Except for plot 1 (at river level) all plots were circular in shape. Initially the circumference of all individuals between 10 mm and 100 mm diameter at breast height (dbh) were measured in a plot of 10 m diameter. Then the plot diameter was increased to 20 m diameter and the circumferences of all individuals greater than 100 mm dbh were recorded. In addition species presence/absence, structure and cover data were collected for all vascular plants. The plot along the river was rectangular in shape, 31.5 m x 10 m, to optimally sample the riverine community. A smaller plot of 10 m x 8 m was established within the larger plot. The long axis of the plot ran parallel to the river edge. The same methods were employed on the

King Billy Range where six plots were established along a transect from the river to the ridge top (140 m–420 m a.s.l.). The altitude of the plots was estimated to ± 20 m using clinometer measurements to the surrounding topography. The slopes of plots were also determined using the clinometer.

Floristic data were ordinated using detrended correspondence analysis (Hill & Gauch 1980), one of the least distorting of the indirect gradient methods currently available (Brown *et al.* 1984). Minchin (1987) has reported that this method may result in marked distortions and care needs to be used in interpreting these ordinations.

Nomenclature follows Curtis (1963, 1967), Curtis & Morris (1975), Willis (1970) and Jones & Clemesha (1981), unless otherwise indicated. Vegetation terminology follows Jarman *et al.* (1984).

RESULTS AND DISCUSSION

Both forests are classified as implicate Huon pine rainforest and both show a marked altitudinal variation in species composition (figs 1, 2). Overall, both transects show similar species compositions, 50 species occurring on the Prince of Wales transect and 49 on the King Billy Range transect (Appendix 1). However, there is marked contrast in species dominance and biomass, especially in the higher altitude plots (figs 1, 2; tables 1, 2).

The forest on the Prince of Wales Range is dominated by Huon pine from river level to the scrubline, covering 320 m in altitude (fig. 1, table 1). *Nothofagus cunninghamii* extends to above the scrubline with a fairly consistent dominance of 15–20%. *Atherosperma moschatum* and *Phyllocladus aspleniifolius* tend to be more patchy in their distribution. *Eucryphia lucida* is a dominant species at lower altitudes but drops out and is replaced by *E. milliganii* (dwarf leatherwood) in plots 5 and 6. The latter species exhibits an extremely small leaf form in this area compared with other (high or low altitude) sites in southwestern Tasmania. Total tree density varies between 10–17 trees per 100 m², while mean diameters and basal areas show a marked decrease at higher altitudes (table 1). Huon pine shows a similar individual trend. Above the scrubline, *Acacia mucronata* and *Agastachys odorata* are dominant tree species along with some coppice *Nothofagus cunninghamii* and *E. milliganii*. A few trees of *Phyllocladus aspleniifolius* are also present. No evidence of live or dead Huon pine was

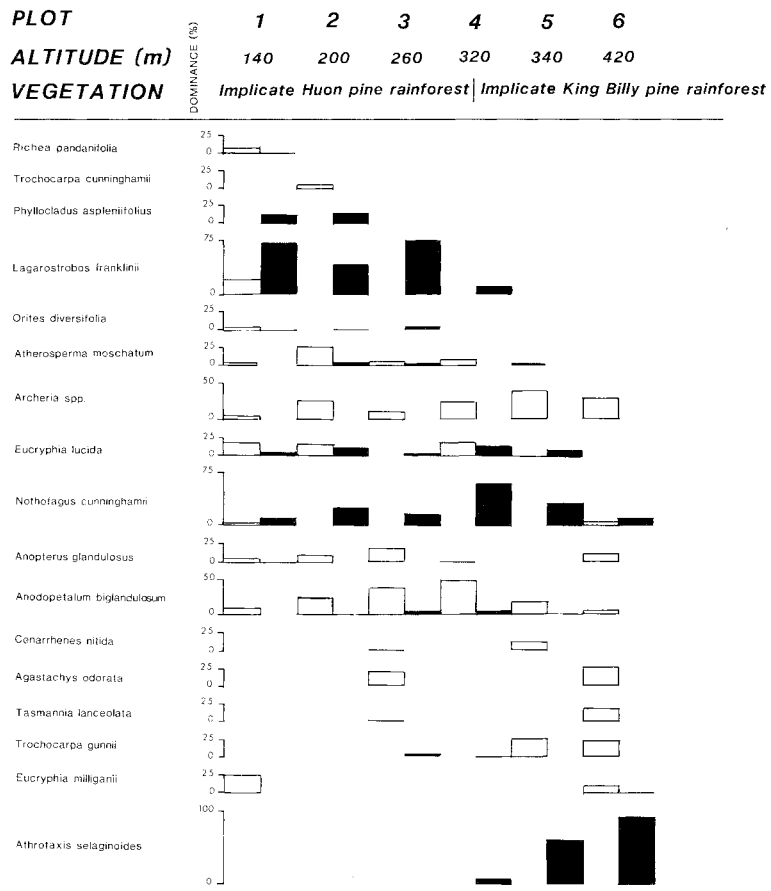


FIG. 1 — Patterns of dominance of tree species (■) and shrubs/sapling species (□) on the Prince of Wales Range transect (relative basal area used as the dominance measure).

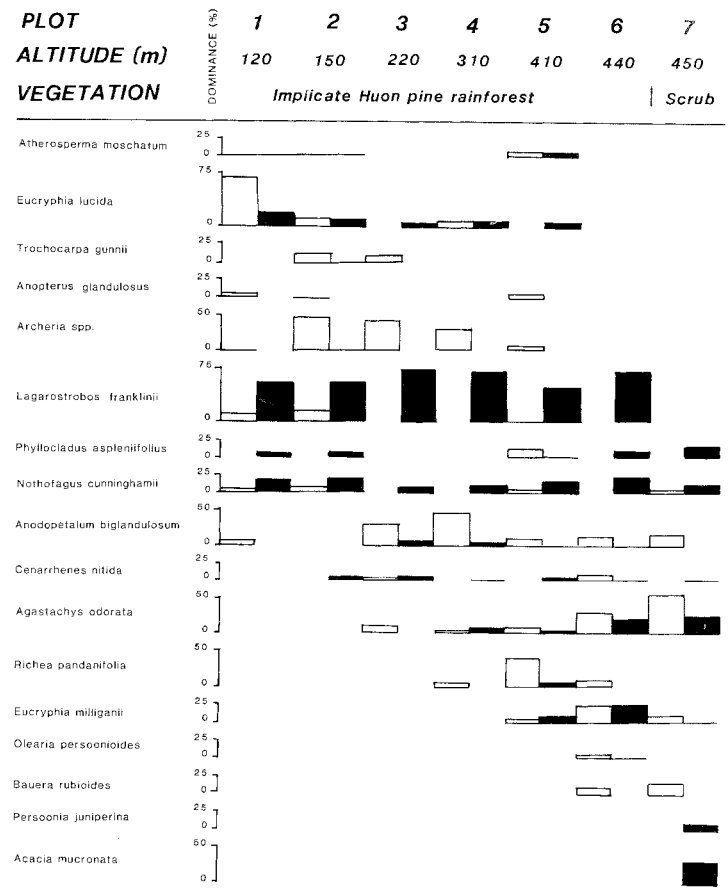


FIG. 2 — Patterns of dominance of tree species (■) and shrubs/sapling species (□) on the King Billy Range transect (relative basal area used as the dominance measure).

TABLE 1
Variation over a Transect on the Prince of Wales Range

Parameter	1	2	3	4	5	6	7
Altitude (m a.s.l.)	120	150	220	310	410	440	450
Vegetation	implicate Huon pine rainforest						scrub
Mean dbh (mm)	301	256	301	285	213	179	207
Tree density (per 100 m ²)	11.8	15.0	13.4	10.2	16.9	15.0	5.1
Basal area (m ²)	0.8430	0.7713	0.9504	0.6482	0.6002	0.3754	0.1710

TABLE 2
Variation over a Transect on the King Billy Range

Parameter	1	2	3	4	5	6
Altitude (m a.s.l.)	140	200	260	320	340	420
Vegetation	implicate Huon pine rainforest			implicate King Billy pine rainforest		
Mean dbh (mm)	268	258	344	262	396	733
Tree density (per 100 m ²)	9.2	13.1	12.1	13.4	9.9	3.5
Basal area (m ²)	0.5217	0.6735	1.1225	0.7260	1.2213	1.4756

found above the scrubline where both tree density and biomass are low (table 1).

The riverine plot shows a high species diversity with 22% of species being restricted to it. There are changes in both dominance and species composition in the shrub/sapling class (>10 mm, <100 mm dbh) with altitude (fig. 1). *Eucryphia lucida* is very common in plot 1. This results in part from disturbance due to logging of Huon pine some 15–20 years previously. In the lower part of the transect *Archeria eriocarpa* and *A. hirtella* are the dominant species. These are replaced by *Anodopetalum biglandulosum*, *Richea pandanifolia* and finally *Agastachys odorata*. Only five sapling class (10–100 mm dbh) Huon pines are found over the entire transect and all but one of these occurs in plots 1 and 2. Above the scrubline *Agastachys odorata* accounts for more than 50% of the shrub/sapling basal area. There is a marked floristic change at the scrubline with 22% of the total recorded species being confined to the top forest plot (plot 6) and scrub plot (plot 7). Only one species, *Nothofagus cunninghamii*, occurs in all plots although a further 16% of species occurs in all the forest plots.

The indirect gradient analysis confirmed these results and showed altitude, or more precisely, those environmental factors which

change with altitude, to be the major underlying environmental gradient. The first axis of the ordination is significantly correlated with altitude ($r = 0.772$, $P < 0.05$).

In contrast, the rainforest on the southern slopes of the King Billy Range is dominated by Huon pine to 320 m a.s.l., above which King Billy pine assumes almost complete dominance (fig. 2, table 2). *Nothofagus cunninghamii* is the major sub-dominant tree species, becoming dominant temporarily at the ecotone between the two pine species (fig. 2). *Eucryphia lucida* is present at low incidence in all quadrats except for plot 6 where it is replaced by *E. milliganii*. *Phyllocladus asplenifolius* is only common in the lower sections of the transect. Tree density of the Huon pine forest is slightly lower than of the Prince of Wales Range, but basal areas show a comparable range (table 2). Extensive selective logging for Huon pine has taken place throughout the lower slopes. This pining probably dates from 1930–40 (Forestry Commission, unpubl. data). The implicate King Billy pine forest (plots 5, 6) has an extremely dense understorey with prolific moss growth 5 m up the trees. The high degree of dominance shown by *Athrotaxis* in the higher altitude plots (fig. 2) is due to large tree size (>1.5 m dbh) rather than high density (table 2). The overall tree density in the

King Billy pine forest decreases with altitude while basal area dramatically increases (table 2).

The riverine plot shows high species diversity with the occurrence of 84% of species; 31% of species being restricted to this plot. Fourteen per cent of species occur in all plots, while a further 6% occur in all but the highest. Eight per cent of species only occur in the high altitude King Billy pine forest (plots 5, 6).

Whilst change in dominance and species composition of the shrub/sapling class does occur (fig. 2), it is not as great as that seen on the Prince of Wales Range (fig. 1). *Richea pandanifolia* and *Trochocarpa cunninghamii* are restricted to the bottom of the transect. *Eucryphia lucida* and *Atherosperma moschatum* extend to plot 5, whilst *Archeria* spp. and *Anodopetalum biglandulosum* are ubiquitous dominant understorey species. *Agastachys odorata*, *Cenarrhenes nitida* and *Tasmania lanceolata* occur at the higher altitudes. *Eucryphia milliganii* occurs in the ridge plot but also in significant numbers at the river. Huon pine saplings only reach significant numbers in the riverine plots.

Indirect gradient analysis again shows that altitude is the major underlying environmental gradient, the first axis of the ordination being significantly correlated with altitude ($r = -0.732$, $P < 0.05$).

CONCLUSIONS

The two areas offer interesting comparisons and contrasts. Both transects show changes in dominance and species composition of both tree and understorey species. Tree species replacement is better developed on King Billy Range and shrub and sapling species replacement is better developed on Prince of Wales Range. The Huon and King Billy pine forests of the King Billy Range show marked differences in both tree density and basal area, while tree density and basal area figures are comparable between the Huon pine forests of the two stands.

There is an interesting contrast in the altitudinal range of Huon pine between the two transects. On the Prince of Wales Range, Huon pine is dominant over 320 m altitude (from 120–440 m a.s.l.) whilst on the King Billy Range it is dominant over 180 m altitude (from 140–320 m a.s.l.) with the upper 100 m of altitude being dominated by King Billy pine. Although occasional individuals of both pine species occur in the other's habitat, the ecotone between the forests is very narrow, occurring over some 30 m in altitude. The

subdominant canopy species *Eucryphia milliganii* replaces *E. lucida* at higher altitudes on the Prince of Wales Range and this transition occurs at the same altitude on the King Billy Range. The question arises as to why Huon pine is replaced on one mountain slope whilst other species show similar distribution patterns on both transects.

There are at least three possible explanations for this replacement. Huon pine may still be expanding its range upslope on the King Billy Range. If this is the case then the process must be extremely slow. The ecotone between the two pine forests is narrow and there is no evidence of old King Billy pine on the lowers being replaced by Huon pine migrating upslope, nor vice versa. Sapling recruitment of Huon pine is also very low in the higher altitude plots, all of which suggest a stable boundary.

The distribution pattern of the pines may be related to geology, since there is a major boundary between Precambrian and Ordovician rocks occurring approximately at the altitude of the ecotone. This may explain the much higher biomass found in the King Billy pine forest. The third possibility is that the pines' distribution may be related to climate. The upper slopes of the King Billy Range are very moist with moss extending 5 m or more up trees. This situation may reflect a "cloud forest" environment preferentially suiting *Athrotaxis selaginoides*. These hypotheses could be tested by reciprocal transplant experiments.

The *Eucryphia milliganii*-*Lagarostrobos franklinii* dominated forests from the upper slopes of the Prince of Wales Range appear to be unique; this being the only known location where there is a significant overlap of their ranges.

The Prince of Wales and the King Billy ranges are of high conservation value and scientific interest given both their floristics and the large extent of the stands. Gibson (1986) considered implicate Huon pine rainforest to be poorly reserved on a state-wide basis. The lower slopes of the King Billy Range have been extensively logged for Huon pine with pre-1950 technology. Although local disturbance in this forest is obvious, the highly selective nature of the logging has not significantly impaired the conservation value of the stand. Both these areas have had a fire-free period of at least 600 years (Gibson 1986). These two stands account for more than 20% of the known extent of Huon pine and probably represent glacial refugia. The only comparable area of non-riverine Huon pine rainforest occurs on the Teepookana Plateau which has been heavily disturbed by modern logging and roading.

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APPENDIX
Vascular Plants on Transects on the Prince of Wales and King Billy Ranges

Plant species	Location		Plant species	Location	
	PWR*	KBR*		PWR*	KBR*
PTERIDOPHYTA					
Blechnaceae			Mimosaceae		
<i>Blechnum minus</i>	+		<i>Acacia mucronata</i>	+	+
<i>Blechnum nudum</i>	+		Monimiaceae		
<i>Blechnum wattsii</i>	+	+	<i>Atherosperma moschatum</i>	+	+
Davalliaceae			Myrtaceae		
<i>Rumohra adiantiformis</i>		+	<i>Leptospermum lanigerum</i>	+	
Gleicheniaceae			<i>Leptospermum scoparium</i>		+
<i>Gleichenia dicarpa</i>	+	+	Oxalidaceae		
<i>Sticherus tener</i>	+	+	<i>Oxalis corniculata</i>	+	
Grammitidaceae			Pittosporaceae		
<i>Grammitis billardieri</i>	+	+	<i>Billardiera longiflora</i>	+	
<i>Microsorium diversifolium</i>		+	Plantaginaceae		
Hymenophyllaceae			<i>Plantago paradoxa</i>	+	
<i>Hymenophyllum australe</i>	+	+	Proteaceae		
<i>Hymenophyllum rarum</i>	+	+	<i>Agastachys odorata</i>	+	+
Psilotaceae			<i>Cennarrhenes nitida</i>	+	+
<i>Tmesipteris billardieri</i>		+	<i>Lomatia polymorpha</i>		+
GYMNOSPERMS					
Podocarpaceae			<i>Orites diversifolia</i>		+
<i>Lagarostrobos franklinii</i>	+	+	<i>Persoonia gunnii</i>	+	
Taxodiaceae			<i>Telopea truncata</i>		+
<i>Athrotaxis selaginoides</i>		+	Ranunculaceae		
DICOTYLEDONS					
Araliaceae			<i>Clematis aristata</i>	+	
<i>Pseudopanax gunnii</i>		+	Rubiaceae		
Compositae			<i>Coprosma nitida</i>		+
<i>Olearia persoonioides</i>	+	+	<i>Coprosma quadrifida</i>	+	+
Cunoniaceae			Rutaceae		
<i>Anodopetalum biglandulosum</i>	+	+	<i>Phebalium squameum</i>	+	
<i>Bauera rubioides</i>	+	+	Violaceae		
Elaeocarpaceae			<i>Viola hederacea</i>	+	+
<i>Aristotelia peduncularis</i>	+	+	Winteraceae		
Epacridaceae			<i>Tasmannia lanceolata</i>	+	+
<i>Archeria eriocarpa</i>	+	+	MONOCOTYLEDONS		
<i>Archeria hirtella</i>	+	+	Cyperaceae		
<i>Cyathodes juniperina</i>	+	+	<i>Gahnia grandis</i>	+	+
<i>Epacris serpyllifolia</i>	+		<i>Tetraria capillaris</i>		+
<i>Monotoca glauca</i>	+		<i>Uncinia</i> spp.	+	
<i>Prionotes cerinthoides</i>	+	+	Gramineae		
<i>Richea pandanifolia</i>	+	+	<i>Microlaena tasmanica</i>		+
<i>Sprengelia incarnata</i>		+	<i>Microlaena stipoides</i>	+	
<i>Trochocarpa cunninghamii</i>	+	+	Iridaceae		
<i>Trochocarpa gunnii</i>	+	+	<i>Diplarrena latifolia</i>	+	+
Escalloniaceae			<i>Libertia pulchella</i>	+	+
<i>Anopterus glandulosus</i>	+	+	Juncaceae		
Eucryphiaceae			<i>Juncus</i> spp.	+	
<i>Eucryphia lucida</i>	+	+	Liliaceae		
<i>Eucryphia milligani</i>	+	+	<i>Astelia alpina</i>		+
Fagaceae			Restionaceae		
<i>Nothofagus cunninghamii</i>	+	+	<i>Calorophus elongatus</i>	+	
			<i>Calorophus</i> sp.	+	+
			<i>Restio tetraphyllus</i>		+

* PWR = Prince of Wales Range, KBR = King Billy Range.