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The Present and Past Occurrence of Beech (*Nothofagus cunninghamii* Oerst.) at Wilsons Promontory, Victoria, Australia

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Summary

The distribution of beech at Wilsons Promontory is described, and the status of stands in which it occurs discussed. Associated species and soils are listed. An historical account of the species in the area over the last 6000 years is based on evidence from pollen analysis and radiocarbon dating.

Introduction

Beech (*Nothofagus cunninghamii* Oerst.) was first reported from Wilsons Promontory by Hardy (1905) but no information about its distribution there, nor of its status (as a forest dominant or shrub) has since been published. Although fires have probably affected the pre-European distribution of this species it is of interest to see whether it is now declining or advancing. From a biogeographic point of view, the occurrence of cool temperate rain forest on Wilsons Promontory is also of interest, as the nearest present occurrence is near Gunyah Gunyah separated by the Yanakie Isthmus which is too dry to support beech or other rainforest species.

Distribution and Habitat

Today, beech is restricted on Wilsons Promontory to a few small areas. Only one known area remains relatively undamaged—less than half an acre on the west side of Mt. Latrobe at 1960 ft. Both the other known occurrences of beech are in fire damaged areas: one at the back of the burnt lilly pilly (*Eugenia smithii*) stand at Sealers Cove, the other at 780 ft south of Mt. Ramsay in the headwaters of 'Fireplace Creek'. This flows into Sealers Cove and crosses the Sealers Cove Track less than a mile from Windy Saddle. Another area where beech might be found is on the east side of Mt. Latrobe in the headwaters of Five Mile Creek. Aerial photographs do not always show small beech stands, so do not provide reliable evidence.

Beech requires a constantly moist environment, and in the Central Highlands is usually restricted to areas with a rainfall of 60 in. per annum or more. At Tidal River, Wilsons Promontory, the mean annual rainfall is 45 in., evenly distributed throughout the year. On the basis of the increase in precipitation with altitude it is probably safe to assume that both Mt. Latrobe and Fireplace Creek receive about 60 in. per annum. A considerable amount of this moisture probably comes from the frequent fogs.

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Although open areas on Wilsons Promontory are occasionally subject to frost, it is most unlikely that the interior of the beech forest is severely affected. This has proved to be true on Mt. Donna Buang (Central Highlands) at 3300 ft, where temperatures outside the forest often fall below freezing point, whilst within the forest they remain at or above freezing point.

Another factor contributing to a continuously damp environment is the protected position of the stands: they are in deep valleys and on sheltered aspects away from prolonged exposure to direct sunlight and drying winds, particularly westerlies and northerlies.

Description of Stands

Mt. Latrobe 1960 Feet (see Fig 1, Table 1): About a dozen unburnt beech trees up to 75 ft tall make up this stand, which is situated in a shallow south-facing valley in the headwaters of Tidal River. The present form of the trees with dead crowns and close set branches in the mid-region (Fig. 1) could be due to increased influence of drying winds. This may be a result of removal by fire of the surrounding eucalypts, since those regenerated are not yet as tall as the beech. Alternatively, the beech trees themselves may have been burnt, as their form is similar to that of trees which are known to have suffered a single light burn. When Ewart and his party passed this way in 1908 (Ewart 1909) they did not record beech and it is possible that the 1907-08 summer fire may have rendered this species unrecognizable.

Small trees of sassafras *(Atherosperma moschatum),* commonly associated in Victoria with beech up to 4000 ft, are present, but only one large tree (60 ft high). Several wet sclerophyll forest understorey species (shown by asterisks in Table 1) are also present: in beech forests the latter usually indicate past disturbance, particularly by fire.

Surrounding the dozen or so mature beech is a dense stand of *Pomaderris aspera, Olearia argophylla* and *O. phlogopappa* under *Eucalyptus obliqua* and possibly *E. regnans.* The ground is fern-covered (mainly *Polystichum proliferum*) with clumps of *Gahnia psittacorum,* amongst which beech seedlings up to 2 ft high are plentiful; dead and coppicing beech stumps are also common. Present beech regeneration may represent the boundaries of the stand before the 1951 fire.

Further down the valley below the beech stand is a swamp with shrubs of *Acacia verticillata, Pomaderris aspera* and *Olearia phlogopappa* up to 15 ft, with a dense 5-7 ft stratum of *Gahnia psittacorum* and *Sticherus tener.* Several young beech trees project through this dense cover; in all cases investigated they are coppice shoots from old stumps, indicating that this area, too, may have been part of the stand before the 1951 fire.

The structure of this small unburnt beech stand is essentially similar to that of other beech forests up to 3500 ft in Victoria, with a sassafras-beech closed canopy at 75 ft, an intermittent tree-fern and shrub stratum at 5-10 ft, a ground cover of ferns, mosses, liverworts and lichens (see Table 1; moss and liverwort lists incomplete). A considerable amount of mossy dead wood lies on the forest floor, and litter cover is thin though continuous.

The soil of the gully is alluvium and colluvium derived from granite, with frequent layers of pebbles. The stream responsible for their deposition still flows through the area.

Fireplace Creek 780 Feet (see Fig. 2, Table 1): This beech stand is confined to the narrow riparian strip of a deeply incised south-flowing stream

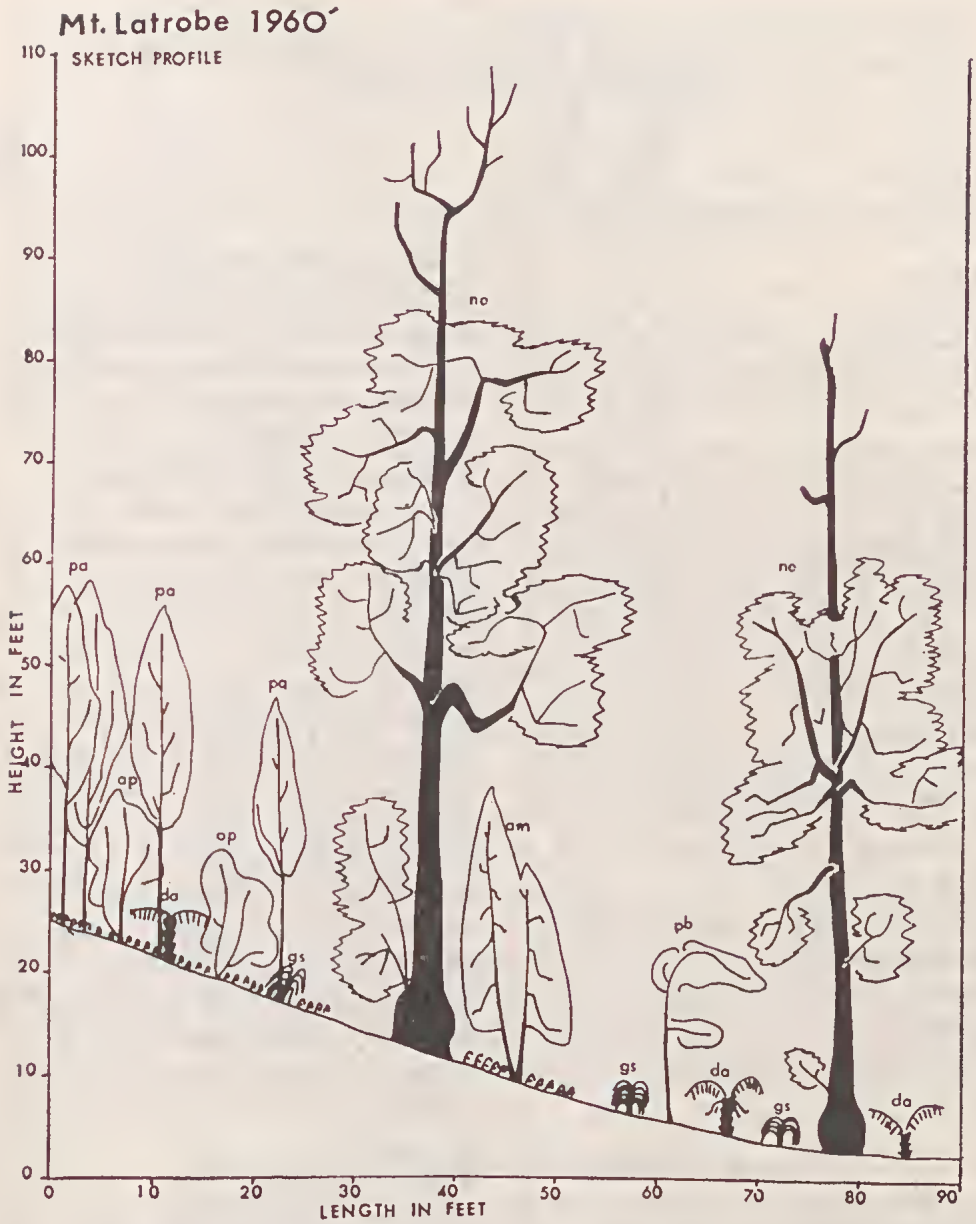

FIG. 1—Mt. Latrobe Sketch Profile (taken from photograph) showing dead tops on Beech (nc) and the boundary with the Wet Sclerophyll Forest—see *Pomaderris aspera* (pa) and *Olearia phlogopappa* (op). Other abbreviations: da = *Dicksonia antarctica;* am = *Atherosperma moschatum;* gs = *Gahnia psitticorum;* pb = *Pittosporum bicolor.*

TABLE 1

*Species present in two beech stands on Wilsons Promontory. *Species recruited from surrounding Wet Sclerophyll Forest*

	FIREPLACE CREEK 780 ft.	MT. LATROBE 1960 ft.
ANGIOSPERMS		
* Acacia melanoxylon R. Br.	x	
Sambucus gaudichandiana DC	x	
Atherosperma moschatum Labill.	x	x
Coprosma quadrifida (Labill.) Robinson	x	x
Fieldia australis A. Cunn.	x	x
Hedycaria angustifolia A. Cunn.	x	x
Nothofagus cunninghamii Oerst..	x	x
* Olearia argophylla Fv. M	x	x
* Pomaderris aspera Sieber ex D.C.	x	x
Viola hederacea Labill.	x	x
Carex appressa R. Br.		x
Clematis aristata R. Br.		x
* Drimys lanceolata (Poir.) Baill.		x
* Eucalyptus obliqua L'Her.		x
* E. regnans F. Muell.		x
Gahnia psitticorum Labill. forma psilocaulon (Beockl) Bent		x
Hydrocotyle javanica Thunb.		x
Libertia pulchella (R. Br.) Spring.		x
* Monotoca elliptica R. Br.		x
* Olearia phlogopappa (Labill.) DC		x
* Pimelea drupacea labill.		x
Pittosporum bicolor HK.		x
* Tetrarhena juncea R. Br.		x
Uncinia tenella R. Br.		x
Zieria smithii Andr.		x
FERNS		
Asplenium flabellifolium Cav.	x	
Blechnum pattersonii (R. Br.) Mett.	x	
Ctenopteris heterophylla (Labill.) M.D. Tindale	x	
Cyathea australis (R. Br.) Domin	x	
C. cunninghamii Hook. f. in Hook.	x	
Microsorium scandens (Forst. f.) M.D. Tindale	x	
Polyphlebium venosum (R. Br.) Copeland	x	
Asplenium bulbiferum Forst. f.	x	x
Blechnum aggregatum (Colenso) M.D. Tindale	x	x
B. fluviatile (R. Br.) E.J. Lowe ex salomon	x	x
B. procerum (Forst. F.) Swartz in Schtad.	x	x
Dicksonia antarctica Labill.	x	x
Grammitis billardieri Willd.	x	x
Mecodium australe (Willd.) Copeland	x	x
M. flabellatum (Labill.) Copeland	x	x
Rumohra adiantiformis (Forst. F.) Ching	x	x
Hymenophyllum cupressiforme Labill.		x
MOSSES		
Bryum truncorum Brid..	x	
Camptochaete ramulosa (Mitt.) Jaeg.	x	
Cyathophorum bulbosum (Hedw.) C.M.	x	
Philonotis scabrifolia (H. f. & W.) Broth.	x	
Dicranoloma menziesii (H. f. & W.) Par.	x	x
Hypnodendron arcuatum (Hedw.) Mitt.	x	x
Hypnum cupressiforme Hedw.	x	x
Leucobryum condidum (Brid.) H. F. & W.	x	x
Papillaria flavo-limbata (C.M. & Hampe) Jaeg	x	x
Ptychomnion aciculare (Brid.) Mitt.	x	x
Hypnum cupressiforme Hedw. var. filiforme Brid.		x
Leptostomum inclinans (Hedw.) R. Br.		x
Rhacomitrium crispulum (Hf. & W.) Wils.		x
LIVERWORTS		
Chiloscyphus sp.	x	
Riccardia sp.	x	
Umbraculum flabellatum	x	
Plagiochila fasciculata Lindenb.	x	x
Schistochila lehmannia (Lindb.) Nees	x	x
Tylimanthus tenellus (Tayl.) Mitt.	x	x
Chiloscyphus echinellus (L;G.) Mitt.		x
C. tridentatus Mitt.		x
Gackstroemia weindoeferi Herz.		x
Symphyogyna sp.		x
Trichocolea australis St.		x

(Fig. 2). Two components of the stand are the narrow valley bottom on either side of the stream, labelled (a), and the steep slope out of the valley, labelled (b).

The narrow valley bottom bears no signs of having been burnt in 1951; 70 ft sassafras trees, a rich epiphytic flora of *Fieldia australis, Microsorium diversifolium, Asplenium bulbiferum,* etc. and 30 ft undamaged slender tree ferns *(Cyathea cunninghamii)* all point to a period of stability much longer than the 17 years since the last fire. The slope out of the valley, however, supports burnt and coppice beech trees, a low (35 ft) cover of wet sclerophyll forest species *Pomaderris aspera, Olearia argophylla,* etc., as well as charred tree ferns and many dead, non-regenerating beech stumps.

It is possible that the valley sides also were burnt in 1907. When Ewart (1910) travelled along the Sealers Cove Track just after it was put in he noted *Fieldia australis,* the slender tree-ferns and the sassafras, but failed to see the beech. Today, 17 years after the last fire, the beech is visible from the track in two places, but the coppice shoots would have been too small to see only three years after a fire.

Evidence for regeneration from seed either after the 1907 or the 1951 fire is absent, though the present authors saw the coppice beech flowering in 1966. Sassafras, on the other hand, flowers and regenerates prolifically, as witnessed by the numerous small pointed crowns which are visible from the track right down the valley. All tree and shrub regeneration taking place occurs on the slopes of the valley; the forest floor at the bottom is extremely dark with the soil unstable since the course of the permanent stream is subject to frequent changes.

The soils of the area are again granitic in origin, those of the floor and lower sides of the valley being alluvial and colluvial with frequent pebble layers. The soil of the walls is often shallow and held in place by a mat of roots over massive granite. The soil further up the valley walls is also skeletal, with a shallow humus-stained layer (less than one inch) over a variable depth of black to grey-brown sandy gravelly loam, which abuts directly on to massive granite. The litter layer is thin and intermittent, and tends to pile up behind rocks and logs. The whole of the stream bed area is saturated throughout the year, and in winter the sides of the valley are subject to seepage.

In contrast to the Mt. Latrobe stand, the beech in this area appears to have a precarious future. It is difficult for the regenerating stumps to retain a firm hold on the soil, which is being continuously washed away, and no seedling regeneration has been observed. The precarious angle of the beech shown in Fig. 2 helps to explain why two trees which had coppiced since 1951 were found uprooted. It seems likely that sassafras could become dominant in this area as it occupies the sheltered and partly fire-protected valley bottom; a fire in the next 20-30 years may remove the beech permanently.

Comparison of Promontory and Mainland Stands

A brief comparison of the species in Promontory and mainland beech stands was made. The total number of angiosperm species found in Victorian beech forests between 0 and 2000 ft is 43. Of these, 9% are found in Promontory stands alone, 42% are found in mainland stands alone and 49% are shared. The total number of fern species found in the same beech forests is 32. Of these species none are found on the Promontory alone; nearly half (45%) occur on the mainland alone and those remaining are shared. The moss and liverwort floras cannot yet be compared because the Promontory lists are incomplete.

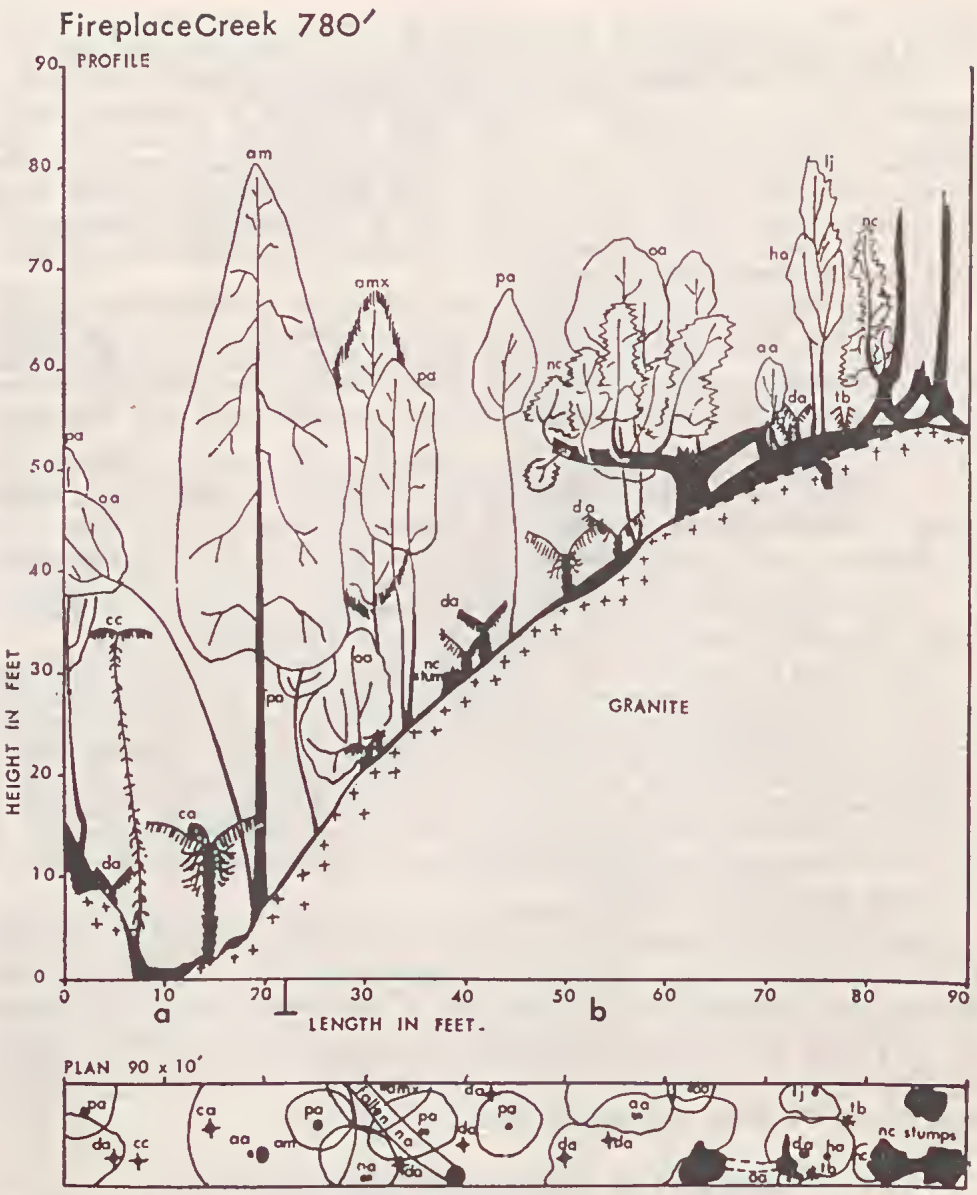

FIG. 2—Fireplace Creek Profile Plan. a = valley bottom, unburnt area; b = valley slope, burnt area. Abbreviations used: pa = *Pomaderris aspera;* oa = *Olearia argophylla;* da = *Dickonsia antarctica;* am = *Atherosperma moschatum;* cc = *Cyathea cunninghamii;* ca = *Cyathea australis;* amx = *Acacia melanoxylon;* nc = *Nothofagus cunninghamii;* tb = *Todea barbara.*

In considering the apparent depletion of both angiosperm and fern floras on the Promontory, it must be noted that information was drawn from eleven of the mainland sites, evenly distributed from 0-2000 ft, but from only two sites on the Promontory. Many fern species absent from beech stands are found in other parts of the Promontory; eight of these species, including *Mecodium rarum, Hypolepis australis* and *Asplenium flaccidum,* occur in the *Eugenia smithii* warm temperate rain forest (Frankenberg 1965).

The angiosperm species found only on the Promontory are recruits from the surrounding wet sclerophyll forest, as are many of the plants found only in the mainland stands.

History of Beech

When beech flowers it produces abundant pollen of characteristic shape. This pollen, together with that of other species, may be preserved over long periods of time in swamp or stream sediments into which it is blown or washed. Cookson (1946) has shown that pollen from a number of species of *Nothofagus* (most of which were probably not closely related to *N. cunninghamii*) is preserved in Tertiary brown coals about 60 miles north of Wilsons Promontory and that the genus had a much wider past distribution than it has at present.

It would seem that since the Tertiary the *N. cunninghamii* forests of Victoria were connected with those of Tasmania, possibly via Wilsons Promontory. The forest probably extended across Bass Strait when it was exposed (Jennings 1959) during one or more of the general lowerings of sea level that occurred in the glacial phases of the Pleistocene. Jennings (1958, 1961) has found probable *N. cunninghamii* wood and pollen on King Island (where beech does not now grow) and the wood has been dated at 37,500 years B.P. which preceedes the maximum of the last glacial phase of about 20,000 years ago. The effective rainfall at sea level must have been higher at the time when the forests of beech on Wilsons Promontory were connected with those of other areas and *Nothofagus* pollen would have been plentiful, even at sites not occupied by forest. This contrasts with the situation today, where, with the exception of areas adjacent to beech stands, beech pollen is found only in trace amounts in material (sediments, peat, moss polsters, etc.) being formed at present.

The study of peats and sediments at Wilsons Promontory (Hope 1968) has provided evidence to support the possible existence of beech there for about 6,000 years. None of the deposits studied contain the large amounts of *Nothofagus* pollen consistent with colonization of Wilsons Promontory by a continuous forest connection. In addition, this colonization would have had to take place across land at present too dry to support the forest, and suitable conditions do not seem to have prevailed in the last 6,000 years.

Two peat deposits have been studied on the Yanakie Isthmus at sites about 7 miles north west of Mt. Latrobe beech stand. An interdune swamp at Darby Beach built up from 6,500 to perhaps 3,000 years ago, and nearby Cotters 'Lake', have been forming continuously for the last 4,000 years, according to radiocarbon age determinations on plant remains (Hope 1968). No *Nothofagus* pollen has been found in the older deposit but it forms low percentages at the base of the Cotters Lake peats. Above this basal zone, the amount declines to occasional grains, with a similar frequency of occurrence to that found in the surface of the bog.

At Tidal River, about 2 miles south west of the Mt. Latrobe beech stand, a more complex deposit, of peat over estuarine sands, has built up over the last

5,000 years (Hope 1968). *Nothofagus* pollen is an important component of the pollen in the sands, forming 10% in most samples. No beech pollen was found in similar sands sedimenting at present from the river near the sample site, even though the headwaters of Tidal River drain the Mt. Latrobe beech stand. Sand build-up ceased about 4,900 years ago and peats have been building up since that time. The percentage of *Nothofagus* pollen declined to around 1% with the onset of peat formation. This decline may have been partly due to the cessation of water transport of pollen to the site, as the pollen in the terrestrial peats must have been blown there by wind.

Peat has formed to a depth of 1 m in the last 4,900 years. The zone with about 1% *Nothofagus* pollen extends from the base of the peat through 50 cm. The next 30 cm above this contains no beech pollen, but traces (less than 1%) are found in the topmost 20 cm and in experimental pollen traps. Although it is dangerous to assume that the peat has built up at an even rate, these depths allow a rough estimation of the age of the changes in pollen amounts. Thus the second decline occurred about 2,500 years ago and the most recent rise about 1,000 years ago.

The evidence from Tidal River suggests that beech was more extensive around 5,000 years ago than it is today. Cool temperate rain forest probably extended over much of the central mountains and down the valleys to a lower altitude, and it was possibly important in the Sealers Cove area. The decline to no more than present-day extent of *Nothofagus* less than 4,000 years ago is shown in both Tidal River and Cotters Lake deposits, while the upper-part of the Tidal River deposit suggests that a slight increase to the present-day distribution took place about 1,000 years ago. The Darby Beach peats contradict the evidence of the other two deposits if their extent from 6,000-3,000 years is true. However, this deposit was not studied as exhaustively as the other two, and the only direct date is 5,890 ± 90 years B.P. from more than half the depth (Coutts 1968). Thus the lack of *Nothofagus* pollen may be attributed to chance, or to a chronological error.

An examination of peat built up in a swampy area 100 m from the Mt. Latrobe stand was made to see if the effect of the recent fires or any older changes could be discerned. The peat has formed on a flat area along a gully which meets the creek that drains the beech stand, but the gully does not drain any area of present *Nothofagus* forest itself. Old trunks and coppices of beech occur at the site but the vegetation consists largely of a dense mass of forked fern *(Sticherus tener)* and *Gahnia psittacorum* with frequent shrubs of *Olearia phlogopappa*. A pit was excavated through peat to a depth of 65 cm. Increasing amounts of gravels and sands occurred from 35 cm depth to the base, which consisted of large boulders. The stratigraphy of the deposit is shown in Fig. 3, which also shows the results of a pollen analysis of a series of samples taken from a face of the pit. The pollen and fern spores from each sample are identified and counted until the 'total count' shown is reached. The results are graphed for each pollen type as a percentage of the total pollen count (which excludes fern spores). Fern spore percentages are also calculated on the total pollen count, so that the sum of all component percentages of both spores and pollen will usually exceed 100%. The values for each type at different depths plotted at the base of the diagram shows the percentages obtained from a surface moss mat collected within the beech stand nearby. The moss catches pollen produced by the modern forest and allows a comparison to be made between the amounts typical of the forest and those found in peat samples.

The profile shows that beech has occupied the sample site during the time that the lower 50 cm of peat has built up, for beech pollen exceeds 55% through this depth. Other elements of a beech forest which were present include kangaroo

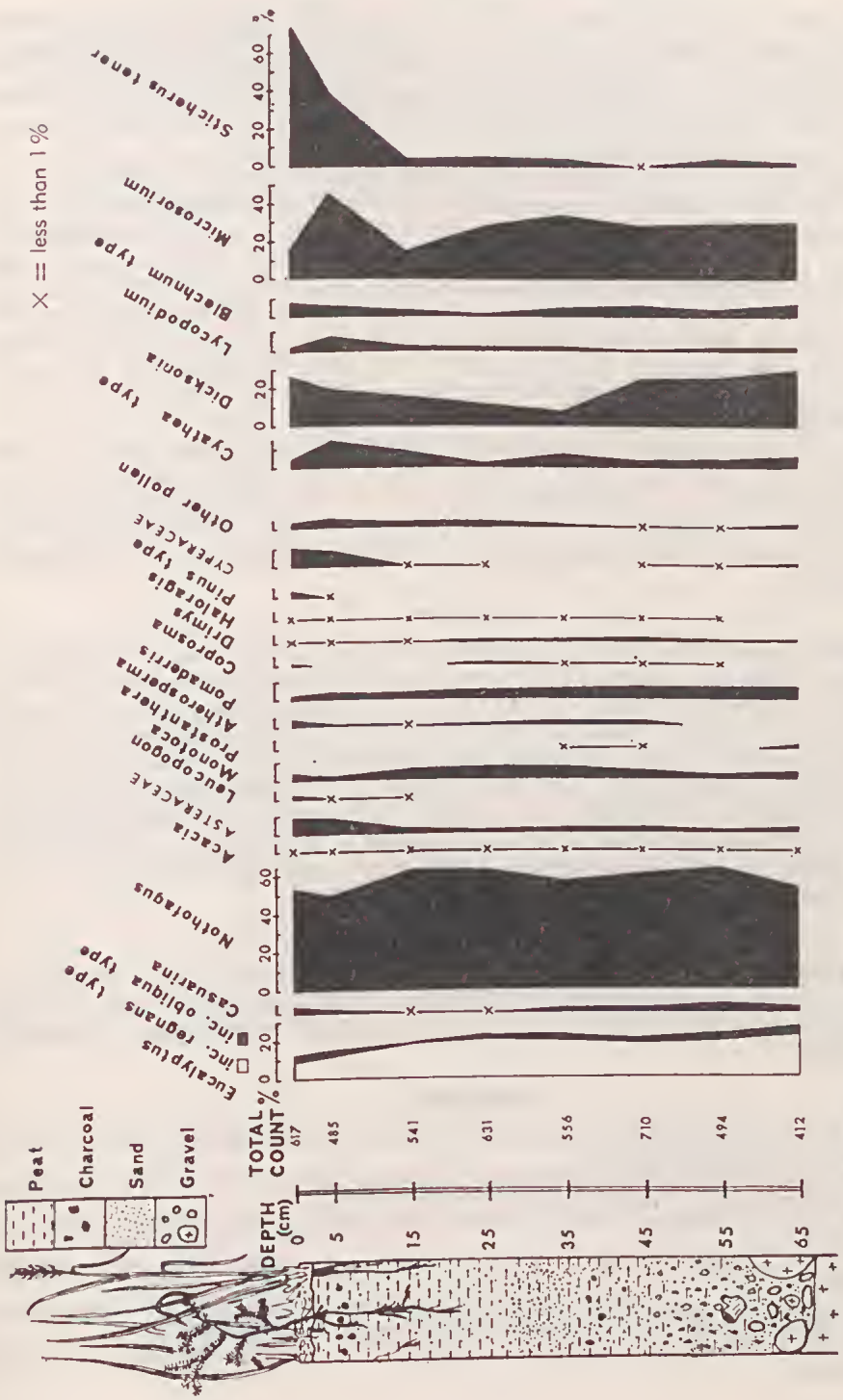

FIG. 3—Pollen diagram from peat deposit on Mt. Latrobe. × = less than 1%. Additional pollen types have been grouped in 'Other Pollen'. These include *Pimelea*, *Halorhagis*, Poaceae, Pittosporaceae and *Pinus*.

fern *(Microsorium diversifolium)* and *Dicksonia* (which were particularly prominent) and *Drimys, Prostanthera, Monotoca, Blechnum, Coprosma* and *Pomaderris. Atherosperma moschatum* was present but only small amounts of pollen were found. Slightly higher values for *Casuarina* and *Eucalyptus* are found in the early stages of deposition compared with later stages and it is possible that a stream may have been present at the site then.

The occurrence of fires is shown by charcoal at 38 cm and in the top 5 cm, but only the latter seems to have affected the vegetation sufficiently to alter the pollen profile. In the samples at 0 cm and 5 cm there is a relative decrease in *Nothofagus* and an increase in Asteraceae, Cyperaceae and *Stichems,* suggesting that it was at this point that the forest occupying the site was destroyed. The fact that the *Nothofagus* pollen is reduced from only 60% to 49% suggests that the stand nearby did escape serious damage and that it has remained a major pollen source. The fires indicated at these upper levels post-date European settlement in Victoria (and hence were probably the fires of 1907) because the pollen from introduced plants (e.g. *Pinus*) is present only in the top 5 cm.

An age for the deposit is suggested by this rate of peat accumulation of 5 cm in 50 years, but it should be noted that the rate of peat build-up during the forest phase is unknown, as is the possible effect of an early stream and of possible truncation of the profile by fire. The inferred age at the base of the deposit is about 650 years and thus *Nothofagus* forest evidently occupied the site continuously for some time.

Conclusion

Evidence from pollen analysis suggests that beech forest was more extensive on Wilsons Promontory about 5,000 years ago when it could have extended down the valley of Tidal River to the west and occupied sheltered sites on the east coast. Today a few small areas of intact beech forest occur in gullies but these occurrences have been reduced in extent by recent fires. It would appear that beech was even more restricted around 6,000, and again about 2,000, years ago and hence the survival of beech is not threatened at present except by fires. Climatic conditions are presumably adequate since active regeneration is taking place at Mt. Latrobe. It seems likely that, in the absence of further fires, beech will re-occupy at least the areas from which it was driven by the 1907 fires.

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