

Dyckerhoffstrasse 3, 4540 Lengerich, Federal Republic of Germany.
Present address: School of Forestry, University of Canterbury, Christchurch.

SHORT COMMUNICATION

NOTHOFAGUS TRUNCATA (HARD BEECH) IN THE UPPER TARAMAKAU CATCHMENT, SOUTH ISLAND, NEW ZEALAND

Summary: Scattered small stands of *Nothofagus truncata* occur in the upper Taramakau catchment, Arthur's Pass National Park, beyond the previously assumed range of the species in north Westland. Restricted to older soils on stable north to north-west slopes, the *N. truncata* stands are surrounded by *N. fusca* dominated forest and their upper altitudinal limits at 370-500 m border *N. fusca*-*N. menziesii* or *N. solandri* var. *cliffortioides* forest. The nearest existing seed sources are located more than 20 km to the north in the Lake Haupiri region, north Westland. *Cyathodes fasciculata* and *Metrosideros perforata* are associated with *N. truncata* in one or more of the stands and are recorded for the first time in Arthur's Pass National Park. The biogeographical significance of the *N. truncata* stands is discussed.

Keywords: *Nothofagus truncata*; *Cyathodes fasciculata*; long-distance dispersal; outlier stands; plant biogeography; Arthur's Pass National Park; Fagaceae.

Introduction

Nothofagus truncata (hard beech) has a wide but discontinuous distribution in the North Island of New Zealand; it is more common in the north-western South Island, where it occurs southward to near latitude 42°30'S (Allan, 1961; June, 1982; J. Wardle, 1984). Disjunct small stands on coastal granitic hills between the Waiatoto and Arawata Rivers in south Westland are separated by more than 250 km from the nearest stands to the north (June, 1977; Mark and Lee, 1985). In north Westland, the eastern (inland) limit of *N. truncata* extends from the western foot of the Victoria Range southwards along the Alpine Fault to near Lake Haupiri. A south-western outlier of the species is located at Blackwater Creek, 5 km north-east of Kumara (Fig. 1), where it is associated with *N. fusca*, *N. menziesii*, and *N. solandri* var. *cliffortioides* (June, 1982; J. Wardle, 1984).

Recently, *Nothofagus truncata* was discovered at Lake Kaurapataka (42°47'S 171°42'E, 413 m a.s.l.), upper Taramakau catchment, beyond the hitherto assumed southernmost distribution of the species in north Westland (P. Wardle, pers. comm.). While studying the distribution of *Nothofagus* in the upper Taramakau catchment, the author found four stands of *N. truncata* in this area.

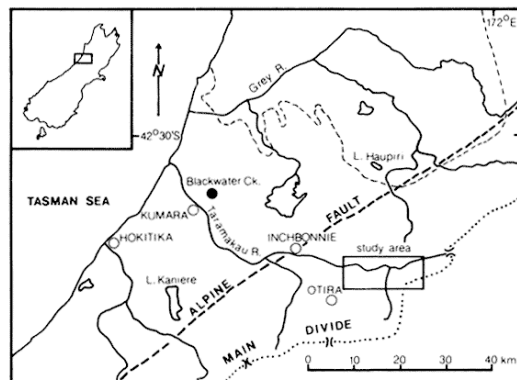


Figure 1: Map of north Westland showing the location of the study area and the regional southern limit of *Nothofagus truncata* (thin dashed line). The solid circle marks one southern outlier stand.

The study area covers the southern part of the upper Taramakau catchment from the Otira confluence to 3 km east of the Otehake River (Fig. 2). Elevation of the broad Taramakau floodplain increases from 250 to 400 m along this west-east distance; on the southern bank, old terraces and flat-topped hills up to 800 m a.s.l. give way to high mountain ranges (>1500 m) culminating in Mt Pfeifer (1703 m) and Mt Koeti (1783 m). North of the Taramakau riverbed the Kaimata Range rises

* Nomenclature follows Allan (1961) and Moore and Edgar (1970) except where other authors are cited.

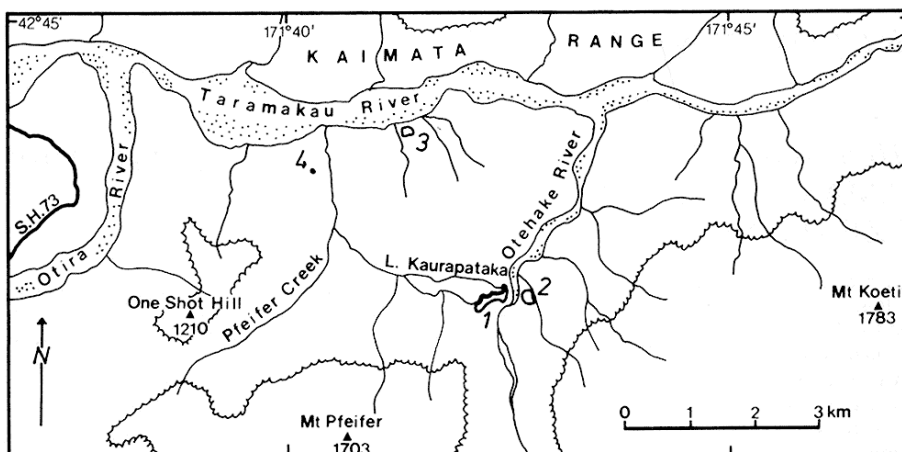


Figure 2: Map of the upper Taramakau catchment with the location of *Nothofagus truncata* stands (1-4). The regional treeline is indicated. The south bank of the Taramakau River represents the northern boundary of Arthur's Pass National Park.

steeply to 1500-1700 m. The local rocks are thick-bedded sandstones and siltstones (Monotis Zone) of the Torlesse Supergroup (Late Triassic). Floodplain gravels and locally extensive debris flows are of Holocene (Aranuian) age (Cave, 1987). Upland and high country podzolised yellow-brown earths and podzols and their related steepland soils (Oтира, Lewis, and Whitcombe sets) are developed on the Torlesse parent rocks. The floodplains and terraces of the Taramakau and its major tributaries support lowland yellow-brown earths (Ikamatua set) or recent soils of the Hokitika set (New Zealand Soil Bureau, 1969).

The wide, west-east orientated valley of the Taramakau River allows maritime air masses to penetrate inland up to the main divide during westerly weather patterns, thus ameliorating the climate. Average annual precipitation is 4570 mm at Inchbonnie and 4911 mm at Oтира (Fig. 1), but there are no rainfall or other climatic records from the upper Taramakau catchment.

The forests and scrublands of the region have been briefly described by Wardle and Hayward (1970). The forests east of the Oтира River are dominated by *Nothofagus fusca*. Towards higher elevations and on poorly drained sites, *N. menziesii* and *N. solandri*; var. *cliffortioides* become more common, but in general, *N. fusca* ascends to 900-1000 m and forms the upper limit of tall forest, which is below a 150-200 m wide belt of subalpine scrub. East of the Otehake River the upper limit of *N. fusca* decreases rapidly and the species soon becomes restricted to discontinuous stands on the Taramakau floodplain. Here, podocarp-broadleaved forest with *Dacrydium*

cupressinum grades into montane and subalpine forests with *Metrosideros umbellata*, *Weinmannia racemosa*, *Quintinia acutifolia*, and *Podocarpus hillii* at higher elevations. The floodplain of the Taramakau River is occupied by grassland with large patches of gorse (*Ulex europaeus* L.) and the fern *Pteridium esculentum* (Forst. f.) Cockayne.

A survey of potentially suitable sites (north-south aspect, 300-500 m a.s.l.) in the study area during the summer of 1988/89 located four stands of *Nothofagus truncata* at Lake Kaurapataka, east of the Otehake River, and near the Taramakau River (Fig. 2). At each stand environmental parameters were noted and a species list of the associated and surrounding vegetation was compiled (Table 1, 2). Sample specimens of *N. truncata* and two of its associated species of particular interest were deposited at Arthur's Pass National Park, at Botany Division, DSIR, and at the Department of Plant and Microbial Sciences, University of Canterbury. The present paper discusses the results of this survey with respect to problems concerning the biogeography of *Nothofagus* in New Zealand.

Site descriptions

Stand 1 is located at the south-eastern shore of Lake Kaurapataka (Fig. 2). The large debris flow, which extends east of Pfeifer Creek, supports tall *Nothofagus fusca* forest, but there is an abrupt change in geomorphology, soil types, and forest composition at the south-eastern bight of the lake. At the western margin of stand 1, *N. truncata* forest covers the north to north-west slope to c. 150 m south of the lake shore. *Metrosideros*

umbellata, *Weinmannia racemosa*, and *Quintinia acutifolia* are common canopy trees and there are also occasional *N. menziesii*. At about 450 m a.s.l. *N. solandri* var. *cliffortioides* and *Halocarpus bififormis* (Hook.) Quinn appear additionally and *N. truncata* is completely absent on more level surfaces at 470-480 m altitude, where soils with impeded drainage support low forest dominated by *N. solandri* var. *cliffortioides*, *M. umbellata*, *Q. acutifolia*, and a shrub storey of *H. bififormis* and *Neomyrtus pedunculata*. The latter is also common in *N. fusca* forest but absent under *N. truncata*. Further east along the lake shore, *N. truncata* forest does not attain the former elevation and becomes discontinuous; the stands are separated by either *N. solandri* var. *cliffortioides* or *H. bififormis* low forest depending on slope angle and soil drainage. *N. truncata* re-attains dominance on the narrow ridge between the lake and the gorge of the Otehake River, but on the steep slopes of the gorge it is replaced by *N. fusca*.

Whereas *N. fusca* attains stem diameters of 1-2 m and more in the adjacent forest, most *N. truncata* stems do not exceed 60 cm d.b.h. and stems >80 cm were not recorded throughout the study area.

Stand 2 is located due east of the Otehake Gorge. *Nothofagus truncata* first appears at an elevation of 390-400 m on the north to north-west slope above the floodplain which supports mixed *N. fusca* forest. At c. 450 m *N. solandri* var. *cliffortioides* enters the community and completely replaces *N. truncata* above 480-500 m, where it forms a low forest with *Metrosideros umbellata*, *Quintinia acutifolia*, and *Halocarpus bififormis*.

The epacridaceous shrub *Cyathodes fasciculata* is common in the undergrowth of stand 1 and 2 and was also locally encountered on the north face of One Shot Hill. It occurs mostly as a small stunted form (<1 m) but reaches a height of up to 4 m on favourable sites.

Stand 3 is located east of the western creek draining the flat-topped hill north of Lake Kaurapataka. *Nothofagus truncata* occupies the NNW-facing slope from 300-370 m a.s.l. *Metrosideros umbellata*, *Weinmannia racemosa*, *Quintinia acutifolia*, and scattered trees of *N. menziesii* and *Dacrydium cupressinum* also occur in the canopy. *N. menziesii* becomes more common with increasing altitude and above 370 m *N. truncata* is completely replaced by *N. menziesii*-*N. fusca* forest. *N. truncata* is abruptly replaced by *N. fusca* forest on the steep slopes towards the creek and at its eastern and downslope limits. The associated change in ground cover is particularly conspicuous. Whereas there is only a sparse ground cover under *N. truncata*, a

Table 1: Location of the *Nothofagus truncata* sample stands. *Partly on ridgetops; **10-20° in upslope part.

Stand	1	2	3	4
Grid ref.				
(NZMS1/S59)	180470	187469	168498	153492
Aspect	N-NNW	N-NNW	NNW	W-NW*
Slope (°)	5-40	35-45**	35	40
Altitude (m)	413-480	390-500	300-370	400-430

Table 2: List of the vascular flora in the sample stands (+ common; - occasional). *Mostly small stunted forms; ** only very local; ²only small seedlings; ³epiphytic seedlings.

Species	Stand			
	1	2	3	4
<i>Prumnopitys ferruginea</i> ²		+	+	
<i>Podocarpus hallii</i> *	-		-	
<i>Halocarpus bififormis</i>	+	+		
<i>Dacrydium cupressinum</i>			-	
<i>Phyllocladus alpinus</i> *	+	+	+	+
<i>Pseudowintera colorata</i> ²			+	
<i>Metrosideros umbellata</i>	+	+	+	+
<i>Metrosideros perforata</i>			-	
<i>Neomyrtus pedunculata</i>			-	+
<i>Elaeocarpus hookerianus</i>	+ ²	-		
<i>Weinmannia racemosa</i>	+	+	+	+
<i>Quintinia acutifolia</i>	+	+	+	+
<i>Nothofagus menziesii</i>	-		-	
<i>Nothofagus fusca</i>	-	-	-	+
<i>Nothofagus truncata</i>	+	+	+	+
<i>Nothofagus solandri</i>	+	+		
<i>N. truncata</i> x <i>solandri</i>	+	-		
<i>Pseudopanax simplex</i> ²	+		+	+
<i>Pseudopanax linearis</i> ²	+			+
<i>Pseudopanax crassifolius</i>	+ ²		-	
<i>Griselinia littoralis</i> ²	+		+	+
<i>Gaultheria antipoda</i>	-	-		
<i>Pernettya macrostigma</i>	-	-		
<i>Cyathodes fasciculata</i> *	+	+		
<i>Coprosma foetidissima</i>	+ ²	+	+ ²	
<i>Coprosma lucida</i>	- ³			
Ground flora				
<i>Hymenophyllum</i> spp.	+	+	+	+
<i>Cardiomanes reniforme</i> **	-			
<i>Grammitis billardierei</i>	+	+	+	+
<i>Blechnum minus</i>	+			
<i>Blechnum discolor</i> **	-		-	
<i>Polystichum vestitum</i> **			-	
<i>Libertia pulchella</i> **			-	
<i>Gahnia procera</i>	+	+		
Epiphytes				
<i>Hymenophyllum</i> spp.	+	+	+	+
<i>Ctenopteris heterophylla</i>	+	+	+	
<i>Asplenium flaccidum</i>		-	-	
<i>Earina autumnalis</i>	-		-	-
<i>Earina mucronata</i>	-		-	

characteristic undergrowth of *Blechnum discolor*, *Cyathea smithii*, and *Metrosideros diffusa* is often profuse in the adjacent *N. fusca* forest. *M. diffusa* was not recorded in *N. truncata* stands, but small colonies of *M. perforata*, which was occasionally found on north-facing slopes in the upper Taramakau Valley, occur in stand 3 and may constitute the regional eastern limit of this species.

Stand 4 is a small stand of *Nothofagus truncata* at 400–430 m a.s.l. at the north-western end of a short narrow ridge west of Pfeifer Creek. It only contains 20–30 mature trees and a few younger stems and is completely surrounded by *N. fusca* dominated forest.

All *Nothofagus truncata* stands appear clearly limited by environmental boundaries (slope, aspect, soil fertility and drainage), and better adaptation and performance of *N. fusca* and *N. solandri* var. *cliffortioides* is probably the most important factor controlling the local distribution. Although other geomorphologically suitable sites were found to support *N. fusca* forest, the study area may harbour further small *N. truncata* stands.

Discussion

Nothofagus truncata is a lowland to lower montane tree with an altitudinal range from sea level to 600 m (J. Wardle, 1984); it requires warmer climatic conditions than the other three taxa of *Nothofagus* present in the study area. It is particularly adapted to infertile but usually well drained soils (J. Wardle, 1984; Mark and Lee, 1985). Such ecological conditions are only encountered on limited sites in the study area, so *N. truncata* stands are restricted to the warmer north to north-west slopes and ridgetops at comparatively low elevations. This distribution pattern is similar to that described for the more extensive stands in north Westland and western Nelson (Holloway, 1954; J. Wardle, 1984). The upper altitudinal limit of *N. truncata* in the study area does not exceed 500 m a.s.l., but it is uncertain whether this constitutes the potential maximum elevation of the species since the upper limits of stands coincide with noticeable changes in slope angle and related soil conditions, or are on ridgetops. In all stands, *N. truncata* is replaced by other species of its genus at higher elevations.

Although not an extreme disjunction when compared with the south Westland stands, the occurrence of *Nothofagus truncata* in the upper Taramakau catchment represents a considerable southern and inland extension of its previously assumed geographical range in north Westland. The stands are located in an intramontane region 50–54 km from the western coastline and 17–21 km east of the Alpine Fault. The nearest potential seed

sources are the mixed *Nothofagus* forests in the Lake Haupiri region, 22–24 km to the north, and separated from the upper Taramakau by the alpine terrain of the Kaimata and Alexander Ranges. The isolated stand at Blackwater Creek lies 42–46 km to the WNW (Fig. 1). The much smaller disjunctions of up to 3.7 km between the four stands in the study area are within the previously known range of long-distance dispersal of *Nothofagus* seeds (June, 1982; Haase, 1989a, b).

All *Nothofagus truncata* stands in the study area are located above 300 m a.s.l. and can be classified as montane. Because of the limited range for potential downslope retreat during periods of cooler climates, a long-term drop in mean temperature of only 1.0–1.5 °C would have caused local extinction of *N. truncata*. The limited altitudinal range available for the species in the study area, particularly at Lake Kaurapataka (413 m a.s.l.), therefore excludes the possibility of "in situ" survival during the Otira Glaciation. It is suggested that the stands established after long-distance dispersal of *N. truncata* nuts, most probably by wind, from potential seed sources in north Westland, which would involve a minimum distance of 22–24 km. This is considerably beyond the previously accepted maximum air-borne dispersal range of 6(12) km for *N. menziesii* and *N. fusca* (Wardle, 1980a; June, 1982; Allen, 1987; Haase, 1989a), suggesting that the effectiveness of long-distance dispersal of New Zealand *Nothofagus* has been consistently under-estimated in the previous studies.

Pollen of the *Nothofagus fusca* group (which includes all taxa except *N. menziesii*) has been present in low quantities in north Westland pollen profiles since about 10,000 yrs BP; the group experienced significant population growth in the region only from 4000–2400 yrs BP (Moar, 1971; Pocknall, 1980). This population growth of the *N. fusca* group would have increased the seed quantities available for potential long-distance dispersal of *N. truncata*.

Nothofagus truncata, *Cyathodes fasciculata* and *Metrosideros perforata* are new plant records for Arthur's Pass National Park (cf. Burrows, 1986). *C. fasciculata*, which is often associated with *N. truncata*, was also noted in mixed *Nothofagus* forest on the north shore of Lake Haupiri. It has been collected as far south-west as Lake Kaniere (42 °48'S), however (Wardle, 1980b).

As a result of the geographical isolation, the upper Taramakau population of *N. truncata* may constitute a discrete gene pool which could be of interest as a genetic resource if native trees are evaluated for managed production forestry. Genetic investigation of these and other outlier populations

of the species would be of interest and could also yield new insights into problems of New Zealand biogeography.

Acknowledgements

I wish to thank the staff of the Department of Conservation, Arthur's Pass National Park, particularly Peter Simpson and Mike Harding, who supported the field survey for this study in various ways. The Department of Conservation, Hokitika, made its Aickens Base available for field accommodation. The occurrence of *Nothofagus truncata* at Lake Kaurapataka and east of the Otehake River was first reported by Peter Wardle and M. Harding, respectively. Peter Wardle, Colin Burrows, and an anonymous referee checked previous versions of this paper and made helpful suggestions for improvement.

References

- Allan, H.H. 1961. *Flora of New Zealand*, Vol. I. Government Printer, Wellington.
- Allen, R.B. 1987. Ecology of *Nothofagus menziesii* in the Catlins Ecological Region, South-east Otago, New Zealand. (I) Seed production, viability, and dispersal. *New Zealand Journal of Botany* 25: 5-10.
- Burrows, C.J. 1986. Botany of Arthur's Pass National Park, South Island, New Zealand. I. History of botanical studies and checklist of the vascular flora. *New Zealand Journal of Botany* 24: 9-68.
- Cave, M.P. 1987. Geology of Arthur's Pass National Park. *National Parks Scientific Series* No.7. Department of Conservation, Wellington.
- Haase, P. 1989a. A population study of an isolated stand of *Nothofagus menziesii* near Otira, South Island, New Zealand. *New Zealand Journal of Botany* 27: 49-57.
- Haase, P. 1989b. Ecology and distribution of *Nothofagus* in Deception Valley, Arthur's Pass National Park, New Zealand. *New Zealand Journal of Botany* 27: 59-70.
- Holloway, J.T. 1954. Forests and climates in the South Island of New Zealand. *Transactions of the Royal Society of New Zealand* 82: 329-410.
- June, S.R. 1977. A major range extension for hard beech (*Nothofagus truncata*) in the South Island (Note). *Mauri Ora* 5: 119-121.
- June, S.R. 1982 (unpublished). *Ecological studies in the indigenous forests of North Westland, New Zealand*. Ph.D. Thesis, University of Canterbury, Christchurch, New Zealand.
- Mark, A.F.; Lee, W.G. 1985. Ecology of hard beech (*Nothofagus truncata*) in southern outlier stands in the Haast ecological district, South Island, New Zealand. *New Zealand Journal of Ecology* 8: 97-121.
- Moar, N.T. 1971. Contributions to the Quaternary history of the New Zealand flora. 7. Aranuian pollen diagrams from Canterbury, Nelson, and North Westland. *New Zealand Journal of Botany* 9: 80-145.
- Moore, L.B.; Edgar, E. 1970. *Flora of New Zealand*, Vol. II. Government Printer, Wellington.
- New Zealand Soil Bureau 1969. General survey of the soils of the South Island. Regional soil maps. *Soil Bureau Bulletin* 27. Department of Scientific and Industrial Research, Wellington.
- Pocknall, D.T. 1980. Modern pollen rain and Aranuian vegetation from Lady Lake, north Westland, New Zealand. *New Zealand Journal of Botany* 18: 275-284.
- Wardle, J. 1984. *The New Zealand beeches. Ecology, utilization and management*. New Zealand Forest Service, Christchurch.
- Wardle, J.; Hayward, J. 1970. The forests and scrublands of the Taramakau and the effects of browsing by deer and chamois. *Proceedings of the New Zealand Ecological Society* 17: 80-91.
- Wardle, P. 1980a. Ecology and distribution of silver beech (*Nothofagus menziesii*) in the Paringa district, South Westland, New Zealand. *New Zealand Journal of Ecology* 3: 23-36.
- Wardle, P. 1980b. Floristic notes for the region between the Taramakau and Haast Rivers, Westland, New Zealand. *New Zealand Journal of Botany* 18: 53-59.