THE LATE QUATERNARY VEGETATIONAL AND CLIMATIC HISTORY OF FAR NORTHERN NEW ZEALAND

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Frontispiece: The Kauri Sanctuary, Omahuta State Forest.

To Lucy M. Cranwell

pioneer in New Zealand palynology

Abstract

Sediments from 3 peat mires and two lakes from the Aupouri Peninsula, Karikari Peninsula and the Bay of Islands district of Northland, New Zealand, are analysed for their pollen and charcoal records to reconstruct a 100,000-year late Quaternary history of vegetational and climatic change. Northland has a complex geological history which includes Upper Pleistocene to Holocene volcanism. The region has a warm, moist climate, which promotes deep weathering of rocks, clay-rich soils and mass movement, particularly in the period following human settlement with clearance of most of the natural rainforest. Throughout the Pleistocene the climate of Northland remained relatively mild in comparison to the more southern regions of New Zealand. This thesis determines how the far northern vegetational cover and its composition have changed in response to late Quaternary climate changes through detailed pollen analysis of sediment cores. Studies of recent pollen deposits were undertaken to provide analogues for interpretation of the relationship between pollen rain and plant communities. Because New Zealand is one of the few land masses in the southern hemisphere south of 35° S, and lies just poleward of the subtropical convergence, it is uniquely placed to record climatic changes in the vast expanse of the Southern Ocean. These records of climatic fluctuations have global importance because of 1) New Zealand's small size and remoteness from other land masses, 2) the lack of large ice sheets at the Last Glacial Maximum which ensured rapid vegetational response to ameliorating climate, and 3) the potential for correlating high-resolution, well-dated terrestrial and marine records.

At the height of the Last Glacial (Otiran) most of New Zealand south of 37° S was unforested. Landscapes not directly affected by glaciation were largely dominated by grass and shrublands. Forest patches survived in microclimatically favoured locations where they were protected from heavy frosts, cold maritime polar airmasses and strong winds. During the *ca* 100,000 years investigated, the pollen profiles demonstrate that the Northland region retained permanent forest cover, although composition of far northern forests changed significantly in response to fluctuating weather patterns. These vegetational and climatic changes are summarised below:

1) Kaihinu Interglacial, ^{18}O Sub-stage 5c-a, *ca* 100-74 ka

The regional vegetation of far northern New Zealand was dominated by kauri-podocarp-hardwood forest. The most important tall trees were *Agathis australis*, *Dacrydium cupressinum* and *Phyllocladus*. *Ascarina lucida*, a small, frost- and drought-sensitive understorey tree, was common. Angiosperm trees dominated coastal forest. The commonest species were *Beilschmiedia*, *Quintinia*, *Metrosideros*, *Nestegis*, *Elaeocarpus* and *Ixerba brexioides*. The climate is interpreted as having been mild and moist. Temperatures may have been 1-2° C cooler than present.

2) Last Glacial (Otiran), ^{18}O Stages 4-2, *ca* 74-14 ka

Regional vegetation changed significantly during the Otiran Glaciation. Whilst the far northern forests remained predominantly diverse conifer-hardwood assemblages, warmth-loving species became increasingly restricted in their distribution, particularly *Ascarina lucida*. From *ca* 74 ka, *Agathis australis*

became scarce in the Kaitaia area, but remained a significant element of regional forest further east. *Dacrydium cupressinum* was a common emergent tree. Between 74-59 ka, climates were generally cool and moist with increased incidence of winter frost in exposed areas. Lowland forests moved seaward to occupy newly exposed continental margins as sea level retreated consequent upon expansion of global ice caps. The following period from 59-43 ka was characterised by increased abundance of *Dacrycarpus dacrydioides*, *Metrosideros* species, *Quintinia* and *Syzygium maire*. These species are associated with wetter conditions. *Ascarina lucida* was also more common at this time. Regional forests were predominantly podocarp-hardwood assemblages. *Agathis australis* was present in these forests, but not dominant. The climate between 59-43 ka (^{18}O Sub-stage 3b) is considered to have been relatively warmer and wetter than the preceding Stage 4. From 43-24 ka (^{18}O Sub-stage 3a) kauri-dominated mixed conifer-hardwood forest expanded. Significant increases of hardy podocarps *Podocarpus* and *Prumnopitys taxifolia* occurred. *Agathis australis* reached its greatest abundance since the Last Interglacial, and *Ascarina lucida* was scarce. Climate was characterised by drier summers and cooler winters. As glaciation in more southern latitudes intensified, northern climates became increasingly colder, drier and windier, particularly from *ca* 30 ka. Natural fires were more common. The replacement of kauri-podocarp-hardwood forest with beech-podocarp-hardwood forest followed rapidly, and by the Last Glacial Maximum (LGM) Northland forests as far north as Kaitaia were dominated by *Fuscospora*. From Kaitaia south all typically warm northern elements were restricted in their distribution. In the far northern region temperatures may have been depressed by as much as 3-3.5°C, and rainfall was probably reduced to about 2/3 it s present level.

3) The Lateglacial, 14-10 ka

Dacrydium cupressinum, *Dacrycarpus dacrydioides*, *Ascarina lucida* and *Dodonaea viscosa* became more abundant from *ca* 14 ka. *Fuscospora*, *Podocarpus* and *Prumnopitys taxifolia*, which had expanded during the harsher climates of the LGM, became more restricted in their distribution. Climate became increasingly more equable as conditions ameliorated.

4) The Holocene, 10 ka to present

Changes in composition of northern forests progressed even more rapidly from the onset of the Postglacial. Across the far northern region beech-dominated podocarp-hardwood forest was rapidly replaced by kauri-podocarp-hardwood forest. *Fuscospora* declined sharply and became very much restricted in its distribution. *Dacrydium cupressinum* dominated the regional forests. Hardy podocarps, *Manoao colensoi*, *Podocarpus*, *Prumnopitys ferruginea* and *P. taxifolia* became less common than previously. *Ascarina lucida* reached its greatest abundance between *ca* 10 - 7.6 ka. The early Postglacial climate was probably the warmest and most equable for the past 80 ka. Temperatures in the Kaitaia region may have been 1-2°C warmer than present.

The mid- to late Postglacial, from *ca* 7-3 ka, is characterised by the decline in *Ascarina lucida*. *Metrosideros* and *Libocedrus* also became less common, whilst hardy podocarps such as *Manoao colensoi*, *Podocarpus* and *Prumnopitys taxifolia* increased in abundance. Far northern climates were probably slightly drier and cooler in this period as a more seasonal, dry summer/wet, cool winter regime became established. Increased cyclone activity is also suggested during this time. These weather patterns are in line with those suggested for other parts of New Zealand. Climatic variability continued into the late Holocene, and the pollen records indicate vegetation disturbance up to the time of first human settlement.

The appearance of high frequencies of *Pteridium esculentum* and microscopic charcoal in pollen records, coincident with forest decline, is recognised as evidence for Polynesian deforestation. The clearance of indigenous forests occurred as a nation-wide event from 800-600 yr B. P. In Northland, where climates and soils were probably more favourable, deforestation events may have occurred a little earlier. At Lake Tauanui first human impact may have occurred as early as *ca* 1000 yr B. P., and at Lake Taumatawhana by *ca* 900 yr B. P. Forest clearance at the Wharau Road Swamp locality was somewhat later at *ca* 600 yr B. P. Subsequently, European settlement, commencing in the early 1800s, is identified by the advent of exotic pollen types such as *Cupressus*, *Pinus*, *Ulex europaeus* and *Plantago lanceolata*.

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TAXONOMY

The taxonomic nomenclature used in this thesis follows that of Allan (1961), Moore and Edgar (1976), and subsequent revisions made by Brownsey *et al.* (1985), Connor and Edgar (1987) and Webb *et al.* (1988). The new monotypic genus *Manoao* erected by Molloy (1995) replaces that of *Lagarostrobos* for what was previously known as *Dacrydium colensoi* (Connor and Edgar, 1987). *Nothofagus* classifications follow Hill and Read (1991), and Hill and Jordan (1993). *N. fusca* type pollen species are designated *Fuscospora* after McGlone *et al.* (1996). It was not always possible to identify pollen and spores to the lowest taxonomic level as some types from the same family were too similar to differentiate between species. For this reason the following pollen types are recognised and are listed with their constituent taxa:

Leptospermum type	*L. scoparium, Kunzea ericoides*
Metrosideros undiff.	all New Zealand *Metrosideros* spp.
Neomyrtus type	*Neomyrtus* sp., *Lophomyrtus* spp.
Fuscospora	all *Nothofagus* spp. except *N. menziesii*
Podocarpus type	*P. hallii, P. totara*
Taraxacum type	all species in the tribe Lactuceae (Asteraceae)
Cyathea dealbata type	*C. dealbata, C. medullaris*
Cyathea smithii type	*C. smithii, C. colensoi*