A RESURVEY OF THE MISTLETOES *Ileostylus micranthus* AND *Tupeia antarctica* IN THE BAY OF PLENTY

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Ileostylus micranthus and *Tupeia antarctica* are two hemiparasitic shrubs (mistletoes) occurring in the Rotorua Lakes Ecological District (RLED). While the bulk of both species in the Bay of Plenty are found in the RLED there are small populations nearby. These outlying populations are *Tupeia* in the Taumata Scenic Reserve and Raparapahoe Gorge near Te Puke and *Ileostylus* in the Lake Ngahewa / Rainbow Mountain area. A small but viable outlying population within the RLED occurs around the Visitor Centre at the Waimangu Scenic Reserve.

Allan (1961) describes *Ileostylus* as having "flowers usually perfect" while for *Tupeia* he describes the plants as "monoecious to dioecious, occasionally polygamous". Ladley (1997) states "*I. micranthus* is subdioecious (populations contain plants that have male, female or hermaphrodite flowers) and *T. antarctica* is dioecious (plants have either male or female flowers)".

This article is based on a report prepared for the Department of Conservation on work carried out in the first half of 2001, to contact landowners in the Rotorua lakes district that had mistletoes on their property and inform them of the need to conserve and protect them. In the last DoC survey in 1997 mistletoes were recorded in the vicinity of Lakes Ngahewa, Okareka, Rotoehu, Rotoiti, Rotokawau, Rotorua, Tarawera, Tikitapu, Rainbow Mountain, and Waimangu. Some sites were added to the original database through personal communications i.e. Mourea and Okere Falls (S. Beadel) and Lynmore (M. Collie). These locations formed the basis for this survey. After the survey had been completed a plant of

Ileostylus was reported and confirmed from Tarukenga (SH5 NW of Rotorua) and a significant number of *Ileostylus* were reported on the Taumanu and Matawhaura Farms north and south of SH 30 near Lake Rotoehu.

MISTLETOE HOST SPECIES

Norton (1997) states that *Ileostylus* primarily parasitises *Pseudopanax arboreus* in the Rotorua area, while Pardy & de Lange (1997) state that "In general, the favoured host (for *Ileostylus*) is *Pittosporum tenuifolium*, followed closely by *Coprosma robusta*".

Of the 9 NZFRI herbarium vouchers for *Ileostylus* only one (NZFRI 20327) nominates *Pseudopanax arboreus* as the host, whereas all eight NZFRI vouchers for *Tupeia* nominate *Pseudopanax arboreus* as the host. An inspection of AK (Herbarium of the Auckland Institute and Museum) voucher labels for the Bay of Plenty Conservancy shows that there are no vouchers for *Pseudopanax arboreus* being a host for *Ileostylus*.

In this survey no *Ileostylus* was found on any *Pseudopanax* species.

A list of all host species, the numbers of each host and mistletoes found on this survey is given in Appendix 1, and a list of mistletoe hosts not known to be current hosts is given in Appendix 2.

a. *Ileostylus micranthus*

Ileostylus was found on a total of thirty-three host species. Within a population there were invariably at least two hosts, and not uncommonly up to four hosts. However, at three sites - Hauparu Bay, Otautu Bay and the Blue Lake Holiday Park (BLHP) there were notable

exceptions. (The Blue Lake Holiday Park was previously known as the Blue Lake Motor Camp). At Hauparu Bay there were fifteen different host species for *Ileostylus*, and at Otautu Bay (combining both the roadside and village areas) there were eight different host species. In the BLHP and RDC Recreation Reserve combined there were ten different host species. Several host species not previously known in the Bay of Plenty were discovered - *Camellia sasanqua* (camellia), *Cydonia oblonga* (quince), *Hoheria* sp. (hoheria), *Prunus* spp. (2 - flowering peach and plum), *Rhododendron arboreum* cv 'Cornubia', and *Rh. fortunei* hybrid at Hauparu Bay, *Rh. arboreum* cv 'Bibiani', and *Escallonia* sp. (escallonia) at BLHP, *Leptospermum scoparium* (manuka) at BLHP and Otautu Bay, *Schefflera digitata* (pate) at Otautu Bay, *Coprosma lucida* (glossy karamu) and *Pittosporum tenuifolium* var. *colensoi* (kohuhu) at Maniatutu Rd.

The camellia, quince, escallonia and the rhododendron are possibly new New Zealand hosts, and the escallonia has been tentatively identified as *Escallonia* ?x *rigida* (*E. rubra* x *E. virgata*) and a specimen was collected and deposited at the Forest Research Herbarium and has the voucher number NZFRI 24294.

The most common hosts for *Ileostylus* in this survey were *Melicytus ramiflorus* (mahoe) and *P. tenuifolium* var. *tenuifolium* (kohuhu) - accounting for 56% of all *Ileostylus* hosts in approximately equal numbers.

b. *Tupeia antarctica*

Tupeia was only found on two host species - five-finger and *Chamaecytisus palmensis* (tree lucerne). At four locations the two hosts were found parasitised in close proximity - Ronald Rd (Lake Tarawera), the DoC marginal strip at Lake Okareka, Lake Tikitapu Scenic Reserve at the end of Branch Road (Okareka) and Otautu Bay at Lake Rotoehu.

Tupeia had been growing on *Ficus carica* (fig) at the end of Acacia Road (host branch had broken off) and *Carpodetus serrata* (putaputaweta) at Tarawera (mistletoe had recently died).

The Herbarium of the Auckland Institute and Museum has vouchers for two hosts in the BLHP for *Tupeia* not seen in this survey. These are wineberry (*Aristotelia serrata*) and hinau (*Elaeocarpus dentatus*).

At only one site (Otautu Bay) were both mistletoe species found on the same host (tree lucerne).

MISTLETOE POPULATIONS IN DECLINE

a. *Ileostylus micranthus*

Morehu Loop Road : Three host plants had recently died in this area taking with them six mistletoes and another host which was not sighted in the area. A mistletoe tentatively identified previously as *Tupeia* on tree lucerne was identified as *Ileostylus* and another host *Salix babylonica* (weeping willow) was found near the lake. The newly discovered plants on Taumanu/Matawhaura Farms may be considered as being of the same population.
Tarawera Road (where it enters Lake Tikitapu Scenic Reserve from the north). There were reasonable numbers of *Ileostylus* in the corner of the reserve alongside the road in the late 1960s on kohuhu, mahoe and five-finger (G.T. Jane *pers. comm.*) and it would appear that the sole remnant of this species here is the plant high up in the crown of a *Alnus carpinifolia* (alder) across the road. This alder is now dead (December 2001) and possibly suffered from root damage from vehicles accessing the roadside strip.

Te Akau point One (on hawthorn) of two *Ileostylus* on Rotorua District Council Reserve was not found.

b. *Tupeia antarctica*

DoC Marginal Strip (Okareka) : This area is undoubtedly in the most unhealthy state of both host and mistletoe decline of anywhere seen during the survey.

In 1996 there were some 75 tagged five-finger hosts with 203 *Tupeia* plants. The mistletoes and hosts had been assessed for size, health and browse. In the 2001 assessment 39 tags (hosts) were not found and 6 tagged hosts were found to be dead. This loss / mortality represents a 60% decline in host numbers. Of the remaining hosts no mistletoe was seen in 9 trees and in a further 2 hosts dead mistletoes were seen - leaving 17 (22.6%) of the original five-finger hosts bearing live mistletoes. Mistletoe numbers have likewise been affected by the loss of host five-finger. In 1996 there were 203 mistletoes on the tagged five-finger hosts, only 42 live mistletoes were found on this survey - 19% of the 1996 surveyed population. During the 1996 assessment 5 five-finger with 6 mistletoes were recorded but not tagged - these could not be identified with certainty- and in this assessment 2 untagged fivefinger bearing a total of 10 mistletoes were recorded. Of the two tagged tree lucerne plants in the 1996 survey only one tag was found and the number of mistletoes on this host had increased from 10 to 42.

Blue Lake Holiday Park : The number of *Tupeia* has decreased by approximately 25%, mainly owing to the loss of over mature trees along the Okareka Loop Road frontage and in the bushy areas within the park.

MISTLETOE POPULATIONS INCREASED AS A RESULT OF THIS SURVEY

It is emphasised that the apparent increase in mistletoe and host and host species numbers is probably owing to more time being spent surveying areas known to have populations of these plants.

a. *Ileostylus micranthus*

Blue Lake Holiday Park : The known *Ileostylus* population here has increased from 143 to at least 202 plants and the number of hosts and host species have also increased.

Hauparu Bay : Despite the heavy pruning of two silver birch removing some 30+ mistletoes in order to save the host, the number of known *Ileostylus* has increased from 49+ to more than 85 and the number of host species from seven to fifteen and the number of known host plants from nine to thirty-two.

Lynmore : Initially one plant was reported in a group of plane trees on Maori Land, this plant was shown to the author by Mike Collie, who had told Chris Ecroyd of its presence and that information had been passed on to Paul Cashmore (Dept. of Conservation). Further investigation after leaf fall showed that there were two live and one dead *Ileostylus* in the eastern-most tree of the group. A second plane tree in the area was found to have one *Ileostylus* plant on the west side of the mid-crown.

Waimangu : The plants from the last survey "in bush beside entrance sign" were not found despite considerable looking, however, a large plant was found beside the carpark and another on the roadside. During a "show what was found" tour towards the end of the survey several more plants were found around the carpark and along the roadside. Two more plants were found down the track from the visitor centre during a Rotorua Botanical Society Field Trip in early June 2001 (P. Cashmore *pers. comm.*). One plant, possibly the one noted "near Lake Okaro" (Wilcox 1984) was located in the reserve alongside the road to Lake Okaro.

b. *Tupeia antarctica*

Lake Okareka (Excluding the marginal strip): In the previous survey *Tupeia* was reported in numbers low enough to warrant banding on that part of the Lake Tikitapu Scenic Reserve near the Okareka Store - there are now many (possibly 20 fold more) plants in this area.

Several plants were found along the roadside and there was a large population parasitising tree lucerne on the ridge to the north of the lower portion of Summit Road.

Tarawera : Previously mistletoe had been found north of the block of Maori land at Te Miro Point and along Spencer Rd in varying densities to the road end. It was found on this survey through the block of Maori land (between the road and the lake) and across Spencer Road on a private property. It is unlikely to be found much further south owing to residential development especially on the lake side of the road.

Wilson's Bay (East) : This population of "greater than 26" had been described as being in poor condition (Cashmore 2000), however an inspection in July 2001 the population was found to be in excess of 140 plants and that these were in a very healthy condition although only four plants were seen in fruit. The health of these plants could possibly be attributed to the possum (*Trichosurus vulpecula*) control associated with the cultivation of "electric puha".

NEW MISTLETOE POPULATIONS

a. *Ileostylus micranthus*

Coles Bay : Three *Ileostylus* plants were found in the settlement to the east of the end of Curtis Road. One was in a silver birch tree beside the Te Toroa Stream, and two in a plane tree just east of the bridge across a small stream through the settlement. One of the mistletoes in the plane tree is 2m high by 1m wide in superb condition. The other in this tree is very much smaller and also in good health.

Lake Okareka : A population of nine *Ileostylus* plants were found on eight plane trees along a driveway from Acacia Road. There were several other species trees (both softwoods and hardwoods) present but mistletoes were not seen in these. Two large *Ileostylus* were also

found on a northern boundary of a property towards the end of Acacia Road in silver birch, however these host trees are earmarked for felling.

Lake Rotokakahi : This population of *Ileostylus,* north of the Lake Rotokakahi boat ramp, may have been part of a much larger population which extended to the north to the Lake Tikitapu population but has over the years been separated from it by landslips.

Lake Rotowhero : Two plants of *Ileostylus* were found on a piece of land which is part of the Rainbow Mountain Scenic Reserve opposite Lake Rotowhero on the Old Waiotapu Rd. One plant was on *Toronia toru* (toru) and the other on kohuhu. This tree is now the only known mistletoe bearing kohuhu in the Lake Ngahewa / Rainbow Mtn area and has been banded.

Otautu Bay : A population was found along the roadside to the north-west of the settlement. *Tupeia* had been found in the area previously but no *Ileostylus* had been noted at that time even though the two species overlapped. *Ileostylus* was initially discovered early in the survey when a plant was found on *Schefflera digitata* (pate) and extended during the "show what was found" tour to 4 host species and 15 mistletoes. Within the village the population appears to have remained fairly static - some plants have died, some hosts have been trimmed and some new plants found.

b. *Tupeia antarctica*

Hauparu Bay : A new population of *Tupeia* (four plants) was found alongside SH 30. One of these plants appeared to quite old and the other plants 100m away were much younger. The nearest known *Tupeia* populations are the single plants across Lake Rotoiti at Maniatutu Rd, Okere Falls and Lake Rotokawau.

Lake Rotokawau : One *Tupeia* was found on a five-finger in what was previously thought to be a pure *Ileostylus* area. This plant and its host branch are not in great condition and may

not be there for long. It is possible that cattle are browsing both the host and mistletoe by reaching across the fence.

Unsworth Rd : At the top end of Unsworth Rd a single plant of *Tupeia* was found. It may be debated that this hardly constitutes a population but is some 1.5km away from the Wilson's Bay (west) site.

As mentioned in the introduction the low numbers of plants, especially at the Maniatutu Road, Okere Falls, Lake Rotokawau and Unsworth Road sites, would hardly constitute viable progenitors for future populations unless there are unsighted plants in these areas.

MISTLETOE POPULATIONS NOT FOUND

Pardy & de Lange (1997) report that scattered plants of *Ileostylus* occur at Waiotapu, and that *Tupeia* was locally common around Te Wairoa (Buried Village) but no sign was found of either species at these sites. No herbarium vouchers are known from these areas.

A single *Ileostylus* on grey willow near the bridge at Mourea (reported by S. Beadel) could not be found.

POPULATION DYNAMICS

The host species (five-finger and tree lucerne) for *Tupeia* tend to be relatively short lived i.e. 15-20 years and if conditions are such that new hosts are not present then there is little hope for continuance of a population. *Ileostylus* being less host specific than *Tupeia* is able to parasitise a larger variety of hosts some with a much greater life span e.g. silver birch and plane trees. Kohuhu seems to be susceptible to mechanical damage especially around the root / trunk interface.

There have been quite considerable changes in the dominant host species in some areas e.g. at the Lake Ngahewa rest area Pardy & de Lange (1997) reported that 4 kohuhu and 1 toru were infected with *Ileostylus*, Cashmore (2000) gives an unspecified number of toru hosts (probably less than four). In this survey all mistletoe was found on toru at this site. However, at the beginning of August 2001 four small plants were found on three tree lucerne which had been planted in 1997 as "mistletoe insurance hosts". Several mistletoes in the cotyledonous stage were also observed on the tree lucerne but not tallied because of the high attrition rate (Cashmore pers. comm.).

At the BLHP there has been an increase in the numbers of *Ileostylus* but a decrease in *Tupeia*. The increase in numbers of *Ileostylus* could possibly be attributed to a more thorough survey, but the decrease for *Tupeia* is because of host mortality.

In the Lake Tikitapu Scenic Reserve there are three distinct populations. To the north at Lake Okareka there is a large population of *Tupeia* and scattered *Ileostylus*, at the BLHP / RDC Recreation Reserve there is a mix of *Ileostylus* and *Tupeia*, and to the south of the reserve there is the population of *Ileostylus* discovered during this survey.

At Tarawera there are two apparently separate areas of *Tupeia* (the only mistletoe species found at Tarawera) with a gap between 528 and 561 Spencer Road. Why there is no mistletoe present is not known as there is good habitat (five-finger) on both sides of the road.

Of the two populations (both *Tupeia*) outside the RLED the one in the Raparapahoe Gorge is small (6 plants) but healthy and although not all the plants previously noted were found more were observed to keep the population relatively static. The other population in the Taumata Scenic Reserve is in two parts, one to the west of Pyes Pa Road and the other around the old hotel site to the south and east of Mangatoi / Pyes Pa Road intersection. This population (both parts) is in serious trouble. The mistletoes, like the Raparapahoe population, were found exclusively on five-finger. Some host plants tended to be quite old

and approximately half of these were in decline. Most mistletoes were heavily browsed, presumably by possums to the extent that the only sign of life was the little green buds poking out from the host stems. Less than a quarter of the mistletoes found had live branches growing from the host stems. Some mistletoes did have leaf but these were few and far between. No plants were seen in fruit. It was obvious that the future of this population is not rosey - possum browse = no leaf = no growth = no fruit = no new plants = eventual extinction even though there are good numbers of young five-finger plants.

THREATS TO MISTLETOE POPULATIONS

Road side maintenance : Several mistletoes of both species have been either lost or have been severely trimmed to mechanical mulching of roadside shrubbery at Otautu Bay, Waimangu and Lake Okareka. Also of concern is that clearance of shrubs and trees under powerlines around some properties at Okareka.

Road realignment : *Tupeia* plants and their hosts have probably been lost along Hamurana Road to the east of Wilsons Bay owing to road realignment and subsequent slips along the fresh surfaces. Road realignment of Miller Road (Okareka) was probably the reason for a roadside population disappearing.

Possums : All areas are susceptible to possum damage but there is considerable speculation as to how much damage these animals actually do (Ogle 1997), although from observations at the Taumata Scenic Reserve these animals must be considered as the browsing agents.

Property maintenance : At the BLHP the maintenance of caravan / camp sites has undoubtedly contributed to the loss of mistletoe plants and hosts to the extent that no mistletoe was found parasitising *Dendrobenthamia capitata* (strawberry dogwood) and several kohuhu have probably been killed by the over zealous use of weed-eaters.

At Otautu Bay many plants of both species of mistletoe on a roadside property were destroyed when host tree lucerne were felled or severely pruned.

CONDITION OF MISTLETOE PLANTS

This survey was started in early January 2001 when there was, in most areas, plenty of fruit around and possum numbers appeared to be low owing to recent localised private poisoning campaigns especially at Tarawera, Okareka and Otautu Bay. The condition of the plants in these areas was exceptionally healthy. Rarely were plants found that had been heavily browsed. Old five-finger trees parasitised by *Tupeia* were characterised by black pustulated bark for a length of up to two metres from which many little green buds were visible or chewed stems with or without leaves emerged. These very old plants / hosts were seen at the end Spencer Road, Tarawera Road at the north-eastern corner of Lake Tikitapu, in the BLHP, at Otautu Bay and in the Taumata Scenic Reserve. Later in the year (August) many *Tupeia* were seen with little or commonly no foliage at all although in all other respects these plants were healthy. This feature is commented on further below.

SOME OBSERVATIONS AND THOUGHTS

Browsing : Is it all done by possums? Why, at the double banded Tarawera Rd five-finger trees, are the *Tupeia* at the top of the tree appear to be severely browsed but lower plants appear virtually untouched? Are katydids, weta or stick insects sneeking out at night? Perhaps kereru (*Hemiphaga novaeseelandiae*) have a go, however, K. Owen (pers. comm.) suggests that if they did they would only browse young foliage - no one has seen them browsing *Tupeia*. *Tupeia* appeared to be more prone to leaf drop than *Ileostylus* (see note on leaf retention below).

Over infection of host : This affliction is not common but was / has been noted in some areas - *Ileostylus* in silver birch at Hauparu Bay, and the two ornamental trees, narrow-leaved

ash (*Fraxinus angustifolia*) and box elder maple (*Acer negundo*) in the BLHP, and *Tupeia* in tree lucerne at Lake Okareka (both the marginal strip and the Branch Road area of the Lake Tikitapu Scenic Reserve. The Hauparu Bay trees had been pruned in March 2000 (Cashmore 2000) with almost total loss of the mistletoes and with, so far little response from the host. Two heavily parasitised tree lucerne at Okareka are over mature so there is not much point in dealing with the problem.

The BLHP ornamental trees are in my opinion becoming over infected and possibly some of the mistletoes should be removed. The health of one of these trees (beside the main driveway near the office) appears to be declining with much branch die-back. Maybe the host is shedding the mistletoes when they get too large. Many of the mistletoes on this host were described in 1993 as being unhealthy and that the cause of the ill-health was undetermined - no browse evident (Pascoe 1993).

Leaf retention : Is *Tupeia* deciduous / semi-deciduous? Are plants induced to lose their leaves after periods of frost / cold weather (as happened in Rotorua during July / August 2001)? A lot of *Tupeia* observed in late August 2001 had lost their leaves. This was especially obvious on exposed female plants at the Okareka marginal strip and the property across the road, or is it a mechanism to expose the fruit to dispersal agents? Several plants with breaking buds were observed to have dropped their leaves and these were found in perfect condition on the ground. When I put the question of deciduousness to Paul Cashmore he replied that he had harboured thoughts of *Tupeia* being semi-deciduous for some time.

On the 31st August 2001 a quick survey of *Tupeia* around the Lake Okareka and Tarawera populations gave the impression that approximately 60% of plants were without leaf, 30% were in partial leaf and the rest appeared to be in full leaf. Very rarely was fruit observed on those plants in full leaf and these were in very sheltered positions. Many of those without mature leaves had no fruit but were in the state of bud burst.

Host canopy density and seed dispersal : Most host trees of both mistletoe species tended to have an open branch habit which allows larger birds such as kereru and tui (*Prosthemadera novaeseelandiae*) easy access for feeding / roosting / preening / defecation etc. At the Waimangu carpark there is a mahoe host with very dense branching which suggests smaller birds such as bellbirds (*Anthornis melanura*) and waxeyes (*Zosterops lateralis*) may be involved with seed dispersal. While kereru do not feature as a seed-dispersal agent in the North Island (Dopson 2001), consideration must be considered at Lake Okareka and Lake Tarawera as there are quite large numbers of these birds in these areas (pers. obs.).

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APPENDIX 1 : BOTANICAL AND COMMON NAMES OF MISTLETOE HOSTS AND THEIR NUMBERS

Botanical name	Common name	Host Numbers	Mistletoe Numbers
(a) *Ileostylus micranthus*			
Acer negundo	box elder maple	1	11
Alnus carpinifolia	alder	1	1
Aristotelia serrata	wineberry	4	15
Betula pendula	silver birch	23	40
Callistemon sp.	bottlebrush	3	10
Camellia sasanqua	camellia	1	3
Chamaecytisus palmensis	tree lucerne	6	8
Citrus sp.	lemon	1	4
Coprosma lucida	glossy karamu	1	1
Coprosma robusta	karamu	3	7
Coprosma tenuicaulis	swamp coprosma	1	1
Crataegus monogyna	hawthorn	11	30
Cydonia oblonga	quince	1	2
Escallonia sp.	escallonia	1	13
Fraxinus angustifolia	narrow-leaved ash	1	48
Fraxinus sp.	ash	1	1
Hibiscus sp.	hibiscus	1	2
Hoheria sp.	hoheria	1	1
Leptospermum scoparium	manuka	3	4
Melicytus ramiflorus	mahoe	70+	238

Muehlenbeckia australis	pohuehue	1	1
Pittosporum tenuifolium var. *colensoi*	kohuhu	1	1
Pittosporum tenuifolium var. *tenuifolium*	kohuhu	70+	208
Platanus x *acerifolia*	London plane	13	15
Prunus sp.	flowering peach	1	3
Prunus sp.	plum	1	2
Rhododendron arborea cv "Cornubia"	rhododendron	1	2
Rhododendron arborea cv "Bibiani"	rhododendron	1	1
Rhododendron fortunei hybrid	rhododendron	1	1
Salix babylonica	weeping willow	4	15
Salix cinerea	grey willow	13	59
Schefflera digitata	pate	1	1
Toronia toru	toru	6	28
		249+	665+

(b) *Tupeia antarctica*

Chamaecytisus palmensis	tree lucerne	13+	166+
Pseudopanax arboreus	five-finger	306+	1542+
		319+	1708+

APPENDIX 2 : RECORDS OF PREVIOUSLY KNOWN MISTLETOE HOSTS

1. *Ileostylus micranthus*

Acacia dealbata	silver wattle	?	Wilcox (1984)
Beilschmiedia tawa	tawa	Mamaku	NZFRI 5392
Dendrobenthamia capitata	strawberry dogwood	BLHP	NZFRI 23344
Embothreum coccineum	Chilean fire bush	BLHP	de Lange (1997)
Pinus muricata	muricata pine	Rainbow Mtn	NZFRI 840
Pseudopanax arboreus	five-finger	Blue Lake	NZFRI 20327
Salix fragilis	crack willow	?	Wilcox (1984)

2. *Tupeia antarctica*

Carpodetus serratus	putaputaweta	Spencer Rd, Tarawera	Cashmore (2000)
Embothreum coccineum	Chilean fire bush	Blue Lake Holiday Park	de Lange (1997)
Ficus carica	fig	Acacia Rd, Okareka	Cashmore (2000)