New Zealand's loranthaceous mistletoes

Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17 – 20 July 1995

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Contents

Introduction

The loranthaceous mistletoes of New Zealand have long been recognised as attractive, unusual and valued components of our forest flora. Few people will forget the sight of a beech (*Nothofagus*) forest at the height of summer when the beech mistletoes *Alepis* and *Peraxilla* are in full bloom. So spectacular are these flowers, that a small sprig of one of these species, the scarlet mistletoe (*Peraxilla colensoi*), was selected to grace the front of our former $2 note. This act is the only instance where a nationally listed threatened plant species has been depicted on New Zealand currency. Unfortunately, the reasons behind the choice of flower had little to do with raising public awareness of the need to conserve mistletoes, but rather was a recognition of the flower's beauty. So it is perhaps today a matter of some irony that at the time of the change to decimal currency, this mistletoe, along with our other Loranthaceae, was a common species, and that now scarlet mistletoe, like the $2 note it once graced, is fast becoming a curiosity of the past.

During the 1980s, the decline of our more visible loranthaceous mistletoes became a matter for public concern, culminating in 1985 with the publication of a review article in the popular Forest & Bird journal by Colin Ogle and Peter Wilson entitled "*Where have all the mistletoes gone?*". This article prompted widespread national interest in the perceived loss of these showy flowers from the beech forests, and also drew attention to the fact that in many parts of New Zealand the presence of any mistletoe was in itself unusual. The article also prompted a return to researching the biology, anatomy, ecology and physiology of these species, while renewing interest in the possible cause(s) of mistletoe decline, or indeed whether such a decline was really occurring.

In 1993 the growing level of interest in the indigenous loranthaceous mistletoes was resulting in problems over the manner in which conservation efforts should be directed, what the research priorities were, and whether they were truly as threatened as the IUCN listings given them by the New Zealand Threatened Plant committee implied. Following on from these wider issues was the need to bring together the wealth of information being gathered on our indigenous mistletoes. The Threatened Species Unit (TSU) of the Department of Conservation was approached to facilitate a workshop to address mistletoe conservation. What resulted was a four day workshop held at the University of Canterbury field station at Cass in July 1995. Invited speakers gave lectures on aspects of mistletoe biology and management, while a breakdown of mistletoe distribution and status was given for each of the Department of Conservation's 14 conservancies. Discussions followed each session and a plan for a national mistletoe strategy developed.

As a result of this gathering it was agreed that the papers presented and accounts given should be published in a proceedings. This publication is the product of this agreement.

Both David and I would like to acknowledge the considerable efforts of Suzanne Clegg (formerly of TSU) in helping facilitate the workshop, and Lynette Clelland (S&R editing) for undertaking the final formatting and editing of the following publication. Ian Mackenzie (S&R editing) designed the frontispiece.

Peter J. de Lange & David A. Norton (editors)
16 May 1996

Part 1 Past and present distribution of New Zealand mistletoes

Historical distribution of New Zealand loranthaceous mistletoes

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SUMMARY

Seven species of loranthaceous mistletoes have been recorded from New Zealand since 1769. These belong to the endemic genera (numbers of accepted species in brackets): *Alepis* (1), *Peraxilla* (2), *Trilepidea* (1) and *Tupeia* (1). Two other genera, *Ileostylus* (1) and *Muellerina* (1) are indigenous to New Zealand, with *Ileostylus* a near-endemic known elsewhere only from Norfolk Island, while *Muellerina celastroides* is a possible vagrant from eastern Australia where it is common.

1. INTRODUCTION

To determine the historical distribution of all seven indigenous loranthaceous taxa we conducted an extensive search of all New Zealand herbaria (and several overseas institutions). The result is a comprehensive database and associated atlas showing the distribution and extent of loranthaceous decline in New Zealand since 1769 (P.J. de Lange, D.A. Norton & B.P.J. Molloy, unpubl. data). In this paper we summarise some of the main points obtained from our research for this atlas. For convenience we follow the vernaculars suggested by Molloy (1990) e.g., those mistletoes which primarily parasitise beech (*Nothofagus*) are referred to collectively as "beech mistletoes", namely *Alepis*, *Peraxilla*; while those which are usually associated with seral vegetation and lowland or coastal forest are treated here as "leafy mistletoes", namely *Ileostylus*, *Muellerina*, *Trilepidea* and *Tupeia*.

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de Lange, P.J., Norton, D.A., Molloy, B.P.J. Historical distribution of New Zealand loranthaceous mistletoes. Pp. 11–22 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

The following notes summarise our understanding of the historical distribution of each of the loranthaceous mistletoe species. Maps showing the distributions derived from herbarium records are appended.

2. THE BEECH MISTLETOES

Alepis flavida (yellow mistletoe; Fig. 1)

This species has been collected from the North and South Islands. In the North Island, it appears to have always been sparsely distributed, being confined to the Central Volcanic Plateau and the main axial ranges (Kaimanawa, Kaweka, and Ruahine) south of Lake Taupo (*cf.* Smith Dodsworth 1991). Aside from this primarily montane distribution, several collections were made from the lowlands around Dannevirke before the turn of the century, and one collection was made from the upper Kaiwhata River (c. 300 m a.s.l.) near Flat Point, Eastern Wairarapa. In the South Island, this species had an historical distribution ranging from d'Urville Island in the Marlborough Sounds to the Waitutu Forest in Southland. Within this area *Alepis* was distributed primarily within the higher altitude beech forest associated within the Southern Alps. Notable outliers include one (possibly two) collections made from Banks Peninsula, and several sampled from northwest Nelson. The historic distribution of this species strongly correlates with that of its principal host tree, black/mountain beech (*Nothofagus solandri* complex).

Peraxilla colensoi (scarlet mistletoe/korukoru; Fig. 2)

Recorded from North and South Islands, this species has a distribution which strongly correlates with that of its principle host, silver beech (*Nothofagus menziesii*). In the North Island, *P. colensoi* has been collected only from those locations supporting silver beech forest, namely Mt Te Aroha in the Waikato, Te Urewera, the Raukumara and Kaimanawa Ranges, from the Ohakune area of the Central Volcanic Plateau, and the Tararua Ranges. In the South Island two main areas of *P. colensoi* were identified and as with the North Island these correlate to known areas of long standing predominantly silver beech forest. Historically, *Peraxilla colensoi* was widely distributed in the ranges north of Lewis Pass whence it extended northwards to the Marlborough Sounds and northwest Nelson. The other main concentration occurred from the Haast area south to Waitutu Forest. Smaller scattered pockets of *P. colensoi* were distributed east of Waitutu from the Southland plains to Dunedin. One notable feature of this species distribution is that, unlike the other beech mistletoes *Alepis* or *Peraxilla tetrapetala*, *P. colensoi* appears to have been most common at lower altitudes (0 – 500 m a.s.l.).

Peraxilla tetrapetala (red mistletoe/pikirangi; Fig. 3)

Considerably less specialised than *P. colensoi*, *P. tetrapetala* still shows a strongly correlated distribution with its principle host, black/mountain beech (*Nothofagus solandri* complex). However, north of latitude 38°S this species utilises tawheowheo (*Quintinia serrata*), and in the far north has been collected from pohutukawa (*Metrosideros excelsa*), puriri (*Vitex lucens*) and towai (*Weinmannia silvicola*). Accordingly, this is the most widely distributed of the beech mistletoes. In the North Island, it appears to have always been sparsely distributed in Northland from its northern limit at Whangaroa Harbour to the upper Waikato and Coromandel, with an outlying population on the summit of Little Barrier Island. South of the Raukumara Ranges this species was more common, primarily following the beech forests of the central and axial ranges. Notable strongholds were parts of Te Urewera, the Central Volcanic Plateau,

Kaimanawa, Kaweka, Ruahine and Tararua Ranges. In the Wellington area this species extends to almost sea level at Muritai, in the Eastbourne Hills. The South Island distribution is somewhat similar to that of *Alepis*, as indeed would be expected as both commonly parasitise the same host complex. Although essentially a high altitude beech forest species of the Southern Alps, *P. tetrapetala* collections show that it also extended into the Marlborough Sounds, northwest Nelson, north Westland, and parts of eastern Otago. The herbaria records show that this species has always been particularly common in the Craigieburn and Lake Ohau areas, suggesting possibly a strong collection bias from these more accessible locations.

3. LEAFY MISTLETOES

Ileostylus micranthus (green mistletoe/scrub mistletoe/pirita/papauma; Fig. 4)

The most widely distributed mistletoe species, *Ileostylus micranthus*, has been collected from North, South and Stewart Islands, and it is also known from Norfolk Island. The distribution of this species shows no obvious national correlation with that of a particular host, but it does show that this is a species of predominantly lowland situations. Also, regional patterns of host specificity have been suggested (Norton 1997). Favoured localities include the *Podocarpus totara* forests of Northland, the regenerating scrub and forest associated with the volcanogenic ejecta of the Taupo Volcanic Zone — especially Rotorua/Taupo, and the grey-scrub communities of Marlborough-Kaikoura, Banks Peninsula, Central Otago (the Lakes District) and Dunedin. *Ileostylus* is also commonly associated with the coastal forests and saltmarshes of Cook Strait, parts of Nelson and Westland. This mistletoe is the most wide ranging of all our indigenous species and has adapted itself to a wide variety of introduced hosts (de Lange *et al*. 1997) which it often parasitises in urban settings.

Muellerina celastroides (Fig. 5)

A vagrant species within our flora. This Australian species was collected twice from one location within the Bay of Islands in the early 1830s. The stated host was pohutukawa (*Metrosideros excelsa*), while the favoured host in Australia is species of *Banksia* and *Casuarina* (N. Reid, pers. comm 1995). The favoured hosts in Australia suggest that its scarcity within New Zealand may be due to the absence of suitable hosts and, as the species has not been reported from the country since, it is treated as "Presumed Extinct" by the New Zealand Threatened Plants Committee (Cameron *et al*. 1995).

Trilepidea adamsii (Adam's mistletoe; Fig. 5)

Never a common species, *Trilepidea* may have always been confined to the region north of latitude 38°S. Very little is known about this species, which is recorded parasitising the following indigenous small trees: *Coprosma arborea* (verified), other *Coprosma* spp., *Melicope ternata* and *Myrsine australis* (Cheeseman 1881, de Lange *et al*. 1997). The little that is recorded about this species suggests that it was primarily a lowland plant (0–400 m a.s.l.), restricted to coastal and lowland kauri (*Agathis australis*) forest. Herbarium specimens show that *T. adamsii* was collected from one site at Waipoua in Northland, the Hunua Ranges, Waiheke Island (Norton 1991), and from the Paparoa inlet in the upper Kaipara Harbour. It was most frequently gathered from near Thames at its type locality, Te Hape Stream, and from nearby Pakirarahi (Norton 1991). In the Waikato, it was reported from one site near Maungakawa (Sanitorium Hill). Literature records also state that this species once grew in the foothills below Mt Moehau (Waikato) (Cheeseman 1925, Norton 1991) and its reported presence on Great Barrier is confirmed by seven water colours painted sometime between 1911 and 1916 (Norton 1991). The last known collection of this species was made in 1954 from Maungakawa and it is now presumed extinct (Cameron *et al*. 1995). Very little can be concluded about the biology of this species, beyond that it must have been an extremely uncommon and possibly rather-specialised species (Norton 1991, Ladley & Kelly 1995). Our lack of knowledge about *Trilepidea adamsii* is unfortunate, all the more so because of the relatively recent extinction date.

Tupeia antarctica (white mistletoe/tapia; Fig. 6)

This species is recorded from throughout the North and South Islands where it has a predominantly easterly distribution. Why this should be so is uncertain, although the pattern may be climatic. Present day strongholds for *Tupeia* are the Rotorua lakes district, the islands of the Cook Strait – Marlborough Sounds (Courtney 1997), Kaikoura, Banks Peninsula and Otago Peninsula. In the latter two sites *Tupeia* commonly extends into urban areas where it parasitises a wide number of exotic hosts, particularly tree lucerne (*Chamaecytisus palmensis*). Within its indigenous habitat *Tupeia*, like *Ileostylus* (with which this species is often associated), favours seral vegetation where it usually parasitises a large number of often short-lived hosts. While no obvious host specialisation is evident, herbaria specimens suggest that *Tupeia* does show some regional preferences, while nationally five finger (*Pseudopanax arboreus*) is the most commonly utilised indigenous host (Norton 1997). Another peculiarity of *Tupeia* is its ability to persist under unfavourable circumstances e.g., heavy shade, as latent host infections. These can, and often, resprout if external conditions become more suitable.

4. CONCLUSIONS

Herbaria specimens show that the most common loranthaceous mistletoe in New Zealand is *Ileostylus micranthus*, followed closely by *Tupeia antarctica*. Both species parasitise a wide number of hosts, the majority of which are associated with seral vegetation associations. Of the two, *Ileostylus* is the only species to extend to Stewart Island and overseas to Norfolk Island. Within New Zealand, it is most frequently encountered within shrubland in low altitude (<300 m) sites, but in some parts of New Zealand (e.g., Northland, and parts of Nelson and Southland) it also shows a strong

preference for totara. *Tupeia* appears to have had a slightly more restricted and primarily easterly distribution. However, like *Ileostylus*, *Tupeia* seems to have favoured seral vegetation within lowland to montane habitats.

Of the beech mistletoes, the most widely ranging is *Peraxilla tetrapetala*. This is also the least host specific of the beech mistletoes. The main stronghold of this species is the black/mountain beech forests of the South Island. However, in the North Island this species was reasonably common within the beech forests of the central and main axial ranges. Closely following *Peraxilla tetrapetala* in abundance, and usually associated with it, is *Alepis flavida*. Herbaria records indicate this species was never common in the North Island, while it has remained common in the beech forests of Canterbury, Otago and Fiordland. In these more southerly sites it is often more abundant than *Peraxilla tetrapetala*. The most specialised beech mistletoe is *Peraxilla colensoi*. This species is restricted to silver beech forest, although within these forests it may parasitise other beech and occasional exotic hosts. This species appears to have never been common in the North Island, while in the South Island it is virtually restricted to two main areas, Nelson and south Westland/Fiordland.

The most uncommon endemic mistletoe is the presumed extinct *Trilepidea adamsii*. Unfortunately, herbarium specimens provide little information beyond that this species was restricted to the North Island within coastal and lowland forests, in associations often dominated by kauri north of latitude 38°S. By way of contrast, the common eastern Australian mistletoe *Muellerina celastroides*, which is also treated as presumed extinct in New Zealand, is probably a vagrant species. It has only been collected twice from the same location in the eastern part of Northland in the early part of the 19th century, and it has not been reported in New Zealand since.

5. ACKNOWLEDGMENTS

The authors would like to thank the curators of the following herbaria; AK, AKU, CANU, CHR, K, MPN, NZFRI, OTA, P, WAIK, WELT, WELTU. We are also grateful for the comments received from the late Margaret (Peggy) Sexton regarding the ecology of *Trilepidea adamsii* on her former Waiheke Island property. Nick Reid kindly commented on the host preferences of *Muellerina celastroides*.

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FIGURE 1. DISTRIBUTION OF *Alepis flavida* (ALL RECORDS 1769 – 1995).

FIGURE 2. DISTRIBUTION OF *Peraxilla colensoi* (ALL RECORDS 1769 – 1995).

FIGURE 3. DISTRIBUTION OF *Peraxilla tetrapetala* (ALL RECORDS 1769 – 1995).

FIGURE 4. DISTRIBUTION OF *Ileostylus micranthus* (ALL RECORDS 1769 – 1995).

FIGURE 5. DISTRIBUTION OF *Muellerina celastroides* AND *Trilepidea adamsii* (ALL RECORDS).

FIGURE 6. DISTRIBUTION OF *Tupeia antarctica* (ALL RECORDS).

Status of loranthaceous mistletoes in the Northland Conservancy

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SUMMARY

The Northland region has a depauperate mistletoe flora compared to other parts of New Zealand, and at least three species previously recorded in Northland are now presumed extinct there. Only one loranthaceous mistletoe, *Ileostylus micranthus*, is widespread, although it is only locally common. At present mistletoe management has centred around banding host trees and informally collecting seed for later "infection" of suitable host sites.

1. INTRODUCTION

Five species of loranthaceous mistletoe have been recorded from Northland namely, *Ileostylus micranthus*, *Muellerina celastroides*, *Peraxilla tetrapetala*, *Trilepidea adamsii* and *Tupeia antarctica* (Cheeseman 1925, Allan 1961, Barlow 1966, de Lange *et al*. 1997). Two of these are now presumed extinct nationally (*Muellerina celastroides*, *Trilepidea adamsii*), while a third, *Peraxilla tetrapetala*, was probably never common in Northland. Similarly, *Tupeia* also appears to have been scarce in Northland; indeed, the only recently reported population of *Tupeia* in Northland has not been relocated (P.J. de Lange, pers. comm. 1995). *Ileostylus*, on the other hand, has been reported frequently throughout Northland and it still persists in many locations where, in some situations, it can be locally abundant.

2. SPECIES AND THEIR STATUS

Presumed extinct species

Muellerina celastroides

An Australian species collected twice from New Zealand, from the Bay of Islands, where the host was pohutukawa (*Metrosideros excelsa*) (B.P.J. Molloy, pers. comm. 1995).

Trilepidea adamsii

Collected only once from the Waipoua River in the early part of this century (Norton 1991), this species has not been reported from Northland since. It may still occur within the region, as no specific searches for it have been made.

Forester, L.J. Status of loranthaceous mistletoes in the Northland Conservancy. Pp. 23–25 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

Extirpated species

Peraxilla tetrapetala

This species, more commonly associated with beech (*Nothofagus*) forest or with stands of tawheowheo (*Quintinia serrata*) outside the region, has been collected from only two localities from Northland, and on neither of these hosts. Two collections were made from Whangaroa Harbour (possibly the same site) during the early 1830s, where the hosts were stated to be puriri (*Vitex lucens*) and pohutukawa (*Metrosideros excelsa*). These specimens were erroneously referred to as a species of *Phrygilanthus* (see Allan 1961), but the collections were later redetermined as *Peraxilla* by Barlow (1966). In 1993, this species was collected from the Wekaweka Valley, near Waipoua, where the host was towai *(Weinmannia silvicola*). This host was banded in 1993, after which, ironically, the mistletoe flowered heavily and later died in May 1995.

Extant species

Ileostylus micranthus

This is Northland's only widespread loranthaceous mistletoe. It is locally common on totara (*Podocarpus totara*), Hall's totara (*P. hallii*), and hybrids between these two taxa. There is also one large colony on *Coprosma propinqua* in a saltmarsh margin near Opua (Bay of Islands). This species appears to be confined to mainly regenerating forest and/or forest margins. Sometimes large emergent totara trees in dense forest can also support heavy infestations of this species. The Northland form of *Ileostylus* is typically pendulous and forms great hanging "lanterns".

Tupeia antarctica

A single specimen of this species was collected from Aorangi Island in the Poor Knights Group by A.E. Wright in 1984. A recent search for this species on that island failed to find any plants and it may now be extinct there (P.J. de Lange, pers. comm. 1995). In either case, had only a single plant occurred there, its dioecious habit would have precluded further establishment.

3. MANAGEMENT/MONITORING

I have not seen anything I would describe as "good possum (*Trichosurus vulpecula*) browse" on mistletoe in Northland, though sometimes host trees are damaged by this pest.

Possum-proof bands have been placed on hosts at several *Ileostylus* localities. Kaikohe Field Centre has set up a simple monitoring trial, but this is in its early, untested stages.

One PNA surveyor is particularly good at spotting mistletoe (especially from a moving vehicle) and has increased our *Ileostylus* database significantly. He also collected a lot of seed this season and has "planted" it on hosts at a number of places. Hopefully we will see some good germination.

4. ACKNOWLEDGMENTS

I would like to thank Nigel Miller for his diligent eye for spotting mistletoe, and Nigel Miller, Brian Molloy and Peter de Lange for their comments regarding several of the mistletoe species reported from the area.

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Status of loranthaceous mistletoes in the Auckland Conservancy

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SUMMARY

Four species of loranthaceous mistletoes have been recorded from the Auckland Conservancy since 1769: *Ileostylus micranthus*, *Peraxilla tetrapetala*, *Trilepidea adamsii* and *Tupeia antarctica*. Of these, current (1995) records only exist for two: *Ileostylus micranthus* (which is confined to the mainland) and *Peraxilla tetrapetala* (which is now restricted to Little Barrier). The future survival of *Ileostylus* in the area is now tenuous, as two of the four known populations are under immediate threat from road extensions.

1. INTRODUCTION

Four species of loranthaceous mistletoes, *Ileostylus micranthus*, *Peraxilla tetrapetala*, *Trilepidea adamsii* and *Tupeia antarctica*, have been recorded within the Auckland Conservancy. Of these taxa, recent records (>1990) exist for only two: *Ileostylus micranthus* and *Peraxilla tetrapetala*. Despite their present scarcity, it would seem that none of these loranthaceous taxa were historically common in the Auckland Region. Why this may have been so is uncertain, although archaeological evidence and eyewitness accounts from the early part of the nineteenth century suggest that much of the Auckland Region was repeatedly burned for agricultural and settlement purposes (S. Bulmer, pers. comm. 1994), thus severely limiting the availability of suitable habitats and preferred host species for loranthaceous mistletoes. By the 1860s, the distribution of all four loranthaceous taxa was restricted to areas of relatively unmodified forest e.g., Waitakere Ranges (Cameron & Morton 1993), Hunua Ranges and Outer Hauraki Gulf Islands (P.J. de Lange & G.M. Crowcroft, unpubl. data).

2. SPECIES

Peraxilla tetrapetala

Herbarium and literature records suggest that the most restricted of the loranthaceous taxa recorded from the Auckland Region is *Peraxilla tetrapetala*.

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de Lange, P.J. Status of loranthaceous mistletoes in the Auckland Conservancy. Pp. 27–30 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

On the mainland this species was reported from the Waitakere Ranges (R.O. Gardner, pers. comm. 1994) and the Hunua Ranges (AK!). Within the Hauraki Gulf, this species has been recorded from Little Barrier (Hauturu) Island, where it remains locally common primarily on tawheowheo *Quintinia serrata*. This apparently isolated island occurrence remains an enigma, particularly as this species has never been recorded from nearby Great Barrier (Aotea) Island, which has a larger area of suitable host. Although the full extent of the Little Barrier Island population is unknown, it is currently considered secure. For this reason the conservancy has neither planned to survey nor made provision for the future management of the Little Barrier population (S. Boyd, pers. comm. 1995). Little Barrier plants are notable for their range of flower colour, with green, red, orange and even pure yellow specimens known.

Tupeia antarctica

Tupeia appears to have always been scarce within the conservancy and, unfortunately, there are no extant occurrences known. Literature records suggest this species was once present in the Waitakere Ranges (Cameron & Morton 1993), while herbarium specimens record this species from only two mainland locations: Rewiti (vicinity of Helensville), where it was last recorded in 1886 (AKU 2384!), and Omaha, near Warkworth, where it appears to have been last collected in the 1930s (WAIK 9812!). Unfortunately, *Tupeia* has never been reported from the islands of the Hauraki Gulf and as it has not been seen in the last c. 55 years, it is quite likely that this species is now extinct in the Auckland Region.

Trilepidea adamsii

Probably the most famous of the conservancy's loranthaceous taxa is the presumed extinct species *Trilepidea adamsii*. Historical records indicate that this was always a naturally uncommon and rather specialised species (Norton 1991, de Lange *et al*. 1997). The Auckland Region appears to have been its "stronghold", although even here it was scarce. Herbarium specimens are known from Paparoa Inlet, in the upper Kaipara Harbour; from the Hunua Ranges and from Waiheke Island, where it persisted until at least 1946 (Norton 1991, M. Sexton, pers. comm. 1995). Literature records indicate this species was also present on Great Barrier Island, however there is no extant herbarium specimen known and the only proof that the species was ever present is a series of undated water colours painted by Fanny Osbourne (1859–1933) from a specimen (or specimens) purported to have been gathered by her husband, Alfred, from Tryphena Harbour. That there may have been a herbarium specimen is implied by Cheeseman (1925), who cited a collection made by Alfred Osbourne from this location. Unfortunately, no collection from Great Barrier can be found in New Zealand herbaria today, and this specimen may have been lost (P.J. de Lange, unpubl. data). The last verified occurrences of this species from the region were made from coastal forest near Onetangi Beach, Waiheke Island, between 1940–1946 (AK!, M. Sexton, pers. comm. 1995). Despite extensive and repeated surveys of both Great Barrier and Waiheke Islands, no further plants have been discovered. It would seem that the major cause of its demise in this region was habitat loss, for as a primarily lowland species, many of its past haunts were destroyed by fire and deforestation. However, for island locations such as Waiheke, it is obvious that repeated and unnecessary overcollecting by professional and amateur botanists alike resulted in the unfortunate loss of this species from that island (Norton 1991, P.J. de Lange & B.P.J. Molloy, unpubl. data).

Ileostylus micranthus

The fourth species reported from the conservancy, *Ileostylus micranthus*, was also the most widely distributed within the mainland part of the conservancy, although it has not, despite an abundance of suitable hosts, yet been reported from any of the Hauraki Gulf Islands. Herbarium specimens record this species from eight sites scattered from Omaha and the Paparoa Inlet (upper Kaipara Harbour) in the north, to the Waitakere Ranges, Hunua Ranges and saltmarshes near Kaiaua in the south east. Throughout this area the favoured hosts were totara (*Podocarpus totara*) and *Coprosma propinqua*. Today (1996), this species is known from just four locations (Young 1996): a population of c. 300 individuals near Pukepuke Road, Mahurangi 7 plants near Piha (Waitakere Ranges), c. 150–200 plants near Ararimu, Hunua, and a fourth located on the Kaiaua Beach Road, where c. 50 plants parasitise mainly *Coprosma propinqua* within remnant saltmarsh scattered along a 1 km strip of road verge.

The future prospects of all but the Ararimu population are not good. The Pukepuke Road site is primarily confined to totara trees which are under immediate threat of a proposed road realignment (R.O. Gardner, pers. comm. 1995), while the Piha site (also on totara and Hall's totara (*Podocarpus hallii*) is extremely exposed and in the last two years a large branch supporting a mistletoe was blown off (T. Stein, pers. comm. 1994). However, unlike the Pukepuke site, this location is protected within Centennial Park/Water Reserve Area, which is administered by the Auckland Regional Council (ARC). As part of their management for the area the ARC have recently (1993, 1995) banded the host trees (T. Stein, pers. comm. 1995).

The Kaiaua population is extremely vulnerable. The roadside location does not provide suitable habitat in which host plants can regenerate while the adjoining land is intensively farmed. Therefore, while host recruitment is nil, the mistletoe plants continue to thrive, effectively overburdening and stressing the hosts (de Lange 1994). The result is that many hosts are becoming moribund, while their exposed roadside location is especially vulnerable to random events — storms, accidents etc. (de Lange 1994). In an attempt to secure the site, the Waikato Conservancy — on whose approximate boundary this population occurs — approached Transit New Zealand and the Franklin District Council during 1994, to make them aware of the significance of this site. At this meeting, both agencies provided assurances that the plants will be cared for, but past experience suggests that promises such as these do not necessarily guarantee success, and recently (1995) half this population has had roadfill dumped over it.

The Ararimu population is, in contrast to all other Auckland sites, secure and thriving. It comprises between c.150–200 plants parasitising Hall's totara within small pockets of privately owned, and fenced, QEII bush covenants. The remnants are subjected to regular possum (*Trichosurus vulpecula*) control and host recruitment is occurring. This population was only rediscovered in May 1996, having first been seen in the early 1970s by Mr Terry Hatch of Pukekohe. The discovery of such a vigorous mistletoe population in an area known for its numerous totara forest remnants suggests that with diligent searching further *Ileostylus* populations may also be located.

3. ACKNOWLEDGMENTS

I would like to thank my colleagues Sue Bulmer and Rhys Gardner for their comments and advice. The late Margaret (Peggy) Sexton provided me with much useful information on the habit of *Trilepidea adamsii* and the cause of its loss from her former property on Waiheke Island. Tom Stein, formerly of the ARC, provided an update on the Piha *Ileostylus* population and its proposed and current management regime. Terry Hatch provided information which lead to the successful rediscovery of the Ararimu *Ileostylus* population. Shaarina Boyd commented on the intended management of *Peraxilla* on Little Barrier Island.

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Status of loranthaceous mistletoes in the Waikato Conservancy

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SUMMARY

Four species of mistletoe are, or were, present in the Waikato Conservancy: *Ileostylus micranthus*, *Peraxilla tetrapetala*, *Trilepidea adamsii*, and *Tupeia antarctica*. The future prospects for the survival of these within the conservancy is uncertain.

1. INTRODUCTION

Loranthaceous mistletoes are not a feature of the flora of the Waikato Conservancy. None of the four species recorded from the area (*Ileostylus micranthus*, *Peraxilla tetrapetala*, *Trilepidea adamsii* and *Tupeia antarctica*) were considered particularly common by early botanists working through the area, although some localities, such as the Coromandel Peninsula, were a recognised stronghold for at least two species: *Peraxilla tetrapetala* and *Trilepidea adamsii* (Cheeseman 1925; P.J. de Lange, unpubl. data).

Based on the present Waikato distribution of loranthaceous mistletoes and their principle hosts, we suggest that they were once locally common in the region, and that the extensive polynesian deforestation of the Waikato lowlands (Newnham *et al*. 1989) is the major reason these species had become scarce by the time european botanists visited the area.

2. SPECIES

Ileostylus micranthus

This species is the most common mistletoe in the conservancy. It is presently known from a number of localities, typically consisting of widely scattered individuals with the overall numbers of plants low. The main concentration of this species occurs in the western Waikato and King Country where the

Roxburgh, J., de Lange, P.J. Status of loranthaceous mistletoes in the Waikato Conservancy. Pp. 31–33 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

principal host is totara (*Podocarpus totara*). Elsewhere there are scattered records from the Coromandel Peninsula and the Firth of Thames. One major population occurs amongst remnant saltmarsh vegetation near Kaiaua on the coastal road to Auckland (de Lange 1997). This site is under severe threat because it is on the road verge and there is little vegetation into which new plants can spread. Recently, a large population was found at Tapuwae, near Bennydale. This site consists of a grove of mature totara, tawa (*Beilschmedia tawa*) and kahikatea (*Dacrycarpus dacrydioides*), with eight of the twenty or so totara parasitised by this mistletoe. We presently estimate this population to consist of c. 500–1000 individuals.

Peraxilla tetrapetala

There are scattered records of this species from Moehau (northern Coromandel) and from the Mangakotukutuku Stream, Awaroa Valley, vicinity of the Tawarau forest and the Pirorua Bluffs (western Waikato). In the Waikato this species has been recorded as parasitic only on tawheowheo (*Quintinia serrata*).

Trilepidea adamsii

This species was first described from specimens collected at the Hape Stream, Thames, by James Adams and Thomas Cheeseman in 1880 (Cheeseman 1881). It would appear that it was once locally common at this site, as it may also have been elsewhere on the Coromandel Peninsula. Unfortunately, the Hape Stream is now highly modified and *T. adamsii* can no longer be found there, nor has it been recently confirmed from elsewhere on the peninsula. The most recent record of *T. adamsii* from the conservancy was made in 1954 from Sanitorium Hill (Maungakawa Hill) in the Pakaroa Range near Cambridge (Norton 1991). Despite intensive searches of this area, the species can no longer be found there, and *T. adamsii* is now presumed extinct nationally (Cameron *et al*. 1995).

Tupeia antarctica

This species has been reported only sparingly from the conservancy in the past. In recent years it has been recorded only twice, in 1993 from the Awaroa Scenic Reserve, Kawhia, where it parasitised putaputaweta (*Carpodetus serratus*) and, more recently still (1995), from the southern margin of Waihaha where the same host and tarata (*Pittosporum eugenioides*) were utilised (I. McFadden, pers. comm. 1995). A survey of the Awaroa Valley by one of us (PdL) in May 1995 failed to locate *Tupeia* in the Awaroa Scenic Reserve, and it would seem that the host tree has been swept away through flooding of the Awaroa River.

3. CONCLUSIONS

Within the Waikato, only one species of loranthaceous mistletoe — *Ileostylus* — remains widely distributed. Of the remaining three taxa reported from the region, *Trilepidea* is almost certainly extinct, *Tupeia* critically endangered, while *Peraxilla tetrapetala* is seriously threatened. With such highly fragmented mistletoe populations, the long term survival of these species within the conservancy is rather doubtful.

4. ACKNOWLEDGMENTS

The authors would like to thank Ian McFadden for his comment on *Tupeia* in the Pureora area.

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Status of loranthaceous mistletoes in the Bay of Plenty Conservancy

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SUMMARY

Four loranthaceous mistletoes have been reported within the Bay of Plenty Conservancy. Two of these, *Peraxilla colensoi* and *P. tetrapetala*, are extremely scarce, while *Ileostylus micranthus and Tupeia antarctica* remain locally common. At present little is being done to secure these populations. Limited survey, monitoring and habitat protection has been initiated by the conservancy but considerably more commitment is required to prevent any further losses of these species from the region.

1. INTRODUCTION

Four leafy mistletoes (Loranthaceae) have been reported from the Bay of Plenty Conservancy region, namely, *Ileostylus micranthus*, *Peraxilla colensoi*, *P. tetrapetala* and *Tupeia antarctica* (P.J. de Lange, unpubl. data). Of these, only *Ileostylus* and *Tupeia* remain locally common in the area today. Their decline in the conservancy is attributed as much to habitat loss as it is to possum (*Trichosurus vulpecula*) browse.

The conservancy has recently initiated a scheme of surveying, protecting and monitoring mistletoes, details of which are reported here.

2. MISTLETOE DISTRIBUTION

General information

From records and talking with "old time" bush workers, it appears that *Ileostylus* had been reasonably wide spread in low density podocarp/hardwood or hardwood forests, in older shrub/hardwood sites in cutover forests, and in forest ecotone belts where favored hosts existed.

Pardy, G., de Lange, P.J. Status of loranthaceous mistletoes in the Bay of Plenty Conservancy. Pp. 35–38 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

Considerably fewer sightings of *Tupeia antarctica* and *Peraxilla colensoi* (korukoru) were recorded than *Ileostylus*. This is probably related to the lower numbers of hosts acceptable to these species and the more remote mountainous or higher altitude areas in which they were generally found.

Species

Ileostylus micranthus

Locally common to abundant in the vicinity of Lake Tikitapu (Blue Lake) and along the road to Lake Tarawera. Small infestations occur locally around the northern end of Lake Rotorua and along parts of the shoreline at Lakes Rotoiti and Ngahewa. Scattered plants occur along the roadside section of the Rainbow Mountain Scenic Reserve and at Waiotapu. The wide variety of hosts utilised in the region was first commented on by Wilcox (1984) and since then numerous additional hosts have been discovered. In general, the favoured host is *Pittosporum tenuifolium*, followed closely by *Coprosma robusta*.

Peraxilla colensoi

Recorded once in April 1985 on a silver beech (*Nothofagus menziesii*) from Mt Te Aroha (CHR 438714, *P.J. de Lange*). Despite recent (1994) searches the plant appears to have gone.

Peraxilla tetrapetala

Recently (July 1995) reported from the foothills near Murupara. Specimens were reputedly growing on red beech (*Nothofagus fusca*) (K. Owens, pers. comm., 1995). A plant was also recorded on *Quintinia serrata* in forest near Te Puke during the mid 1960s (C.C. Ogle, pers. comm. 1995) and the species was collected by Athol Caldwell on Mt Te Aroha in 1938 (WAIK 14836).

Tupeia antarctica

Local to locally common around Lake Tikitapu, Lake Tarawera and near Te Wairoa (Buried Village). Also frequent on the mid slopes of Mt Tarawera. Older records exist for Waimangu Valley (last seen there by P.J. de Lange in 1984) — where it is probably still present — and from the Te Puke area (1960s). At Lake Tikitapu this species parasitises a wide variety of hosts but, in general, the favoured host for the region is fivefinger (*Pseudopanax arboreus*).

3. SURVEY, PROTECTION AND MONITORING OF LEAFY MISTLETOES

Currently there is no organised field survey programme being undertaken to locate new populations or to monitor reported sightings. Some records in the region have come from observations made by botanically inclined trampers, but most have been provided by members of the Rotorua Botanical Society during their excursions in the bush.

In places where mistletoes are conspicuous or prone to damage the conservancy has undertaken to band host trees, replant with suitable host and emplace barriers to restrict human or other animal traffic e.g., *Ileostylus* at Lake Ngahewa.

Two *Ileostylus* sites are being monitored currently (see below). In both areas host trees have been tagged and mistletoe health and size assessed.

Site 1: Lake Ngahewa

The site is located within a small carpark bordering the lake besides State Highway 5. Five host trees have been tagged, 4 *Pittosporum tenuifolium*, and a single *Toronia toru*. An average of 7 *Ileostylus* live on each *P. tenuifolium* (range 1–16) with only one plant on the *Toronia*. The site is used as a picnic stop so cars frequently drive close to the host trees, compacting the soil. Tractors mowing the grassed site have killed several potential hosts through debarking. Tree fern edgings infilled with bark have been placed around some of the host trees to prevent further damage. Planting and protecting more host trees is required to sustain the mistletoe population.

Site 2: Lake Tikitapu (Blue Lake)

At the northern end of the lake 27 host trees have been tagged, 6 of those right beside the lake, the other 20 being on the opposite side of the road, in and around the edges of the Blue Lake Camping Ground (Table 1). At this site both *Ileostylus* and *Tupeia* are abundant and parasitise a wide variety of hosts.

Threats to mistletoes in the camping ground and on the lake edge include people climbing trees, tree trimming, and possum browse. In fact, the only known occurrences of *Ileostylus* and *Tupeia* on Chilean flame tree (*Embothrium coccineum*) were by the camping ground kiosk, where the host tree was recently felled (de Lange 1997). The large numbers of these mistletoes in the vicinity of the lake suggests that the constant human and vehicular traffic have helped reduce the impact of possums and this population seems to be stable.

TABLE 1. HOST TREE SPECIES, NUMBER OF HOST TREES, AVERAGE NUMBER OF MISTLETOES PER HOST AND RANGE AND SIZE CLASSES FOR *Ileostylus micranthus* AND *Tupeia antarctica* AT LAKE TIKITAPU.

HOST SPECIES	NO. HOST TREES INFECTED	AVE. MISTLETOES/ HOST	RANGE	SIZE CLASS			
				s	m	l	xl
Coprosma robusta	4	1.8	1–2	1	4	2	0
Melicytus ramiflorus	10	2.9	1–7	10	17	2	0
Aristotelia serrata	4	2.0	1–3	3	2	2	1
Pittosporum tenuifolium	5	6.0	2–14	7	12	7	4
Dendrobenthamia capitata	1	1.0	1	0	1	0	0
Betula pendula	1	2.0	2	1	1	0	0
Unidentified exotics	2	14.0	12–16	4	9	12	3

Plant size: Small = < 30 cm wide or long, Medium = 31–70 cm, Large = 71–100 cm, Extra Large (XL) = > 100 cm.

4. PROPAGATION

No attempts have been made to propagate loranthaceous mistletoes by the Department in the Bay of Plenty Conservancy.

5. FUTURE OF LORANTHACEOUS MISTLETOES IN THE CONSERVANCY

1. The exact distribution of the loranthaceous mistletoes in this area is uncertain and more effort is needed to survey known, historic and suitable sites. In particular, little is known about the current status of *Peraxilla colensoi*, and *P. tetrapetala*.
2. Mistletoes currently do not rate as highly as other threatened species with regard to sites requiring possum control. This is unfortunate, and more effort is needed to raise the profile of these species both nationally and within the conservancy
3. More effort is needed to determine how to propagate mistletoes so that we can manage plants within areas receiving high levels of possum control.

6. ACKNOWLEDGEMENTS

The authors would like to thank Colin Ogle (DoC Wanganui) and Keith Owens (DoC Bay of Plenty) for comments on mistletoe distributions within the region.

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Status of loranthaceous mistletoes in the Tongariro-Taupo Conservancy

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SUMMARY

Five species of loranthaceous mistletoe are known from the Taupo/Tongariro Conservancy. Apart from *Ileostylus micranthus*, all were in serious decline until 1991, when management measures were undertaken. This paper reviews the known distribution of the conservancy's loranthaceous mistletoes, and discusses aspects of their decline and present management.

1. INTRODUCTION

All five extant species of leafy mistletoes are present in the conservancy and apart from *Ileostylus micranthus* all were in decline until management commenced in 1991. At this time, staff believed that all mistletoes had disappeared from the conservancy because no flowers had been seen for a number of years, but when surveys were commenced many plants were found. Currently all species except *Peraxilla colensoi* are responding positively to short-term protective measures (Jones 1997), but there is still a need for long-term measures to ensure that they continue as a component of the biodiversity of the region.

2. NOTES ON INDIVIDUAL SPECIES (Table 1)

Alepis flavida

This species grows on mountain beech (*Nothofagus solandri* var. *cliffortioides*). Formerly recorded from the vicinity of Whakapapa (Ogle & Wilson 1985) and from Lake Rotopounamu (de Lange 1987), this species is now known only from the Round-the-Mountain Track on the southern slopes of Mt Ruapehu. The 13 hosts we have were found by a team surveying for *Peraxilla tetrapetala*. The plants are in good health.

Peraxilla colensoi

Most of our *Peraxilla colensoi* specimens are very high up in mature silver beech (*Nothofagus menziesii*) trees, making them very difficult to find. A few

Jones, C. Status of loranthaceous mistletoes in the Tongariro-Taupo Conservancy. Pp. 39–41 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

TABLE 1. TONGARIRO-TAUPO CONSERVANCY MISTLETOES.

	Alepis flavida	*Peraxilla colensoi*	*Peraxilla tetrapetala*	*Tupeia antarctica*	*Ileostylus micranthus*

Host Species	*Nothofagus solandri* var. *cliffortioides*	*Nothofagus menziesii* *N. fusca*	*Nothofagus solandri* var. *cliffortioides*	*Pittosporum tenuifolium* *P. eugenioides* (2 in garden)	*Kunzea ericoides* *Coprosma robusta* *Melicytus ramiflorus* *Pittosporum tenuifolium* Plum Crab-apple
Number of Populations	1	2 (?3)	3 (?4)	1 (?2)	1 (?2)
Number of Hosts	13	53 (16 + 37)	168	80+	20+
Number Collared/Caged	2 + 2	36	126 + 3	15 +	Nil
Ecological District	Tongariro	Tongariro Kaimanawa	Tongariro	Taupo	Taupo
Land Tenure	DoC	DoC	DoC	DoC Council Reserve Private land	Private land

near Ohakune are on red beech (*Nothofagus fusca*). There are populations at Clements Rd and Kiko Rd in the Kaimanawa Forest Park, and in the Rangataua area, east of Ohakune. Many of the plants are quite large, up to three metres across. The Ohakune population have yellow to orange flowers and the Kaimanawa population are red. Many of the Kaimanawa plants are in serious decline or dead, while the Ohakune plants are suffering browse but appear at least to be holding their own.

Peraxilla tetrapetala

These, in most instances, are on mountain beech trees and occur on the western and southern slopes of Mt Ruapehu. Initial surveys showed many plants to be at least partially dead or showing signs of severe browse. Following management of possums many plants have recovered and are flowering again. It seems that browse often occurs in the autumn, when plants have fruit and/or new shoots containing the beginnings of the next season's growth and flowerbuds. This could prevent plants from ever flowering.

Tupeia antarctica

This species grows on *Pittosporum tenuifolium* and occasionally *P. eugenioides* in a sheltered north-facing area on the shore of Lake Taupo. Where host trees are in the open and mistletoes have a lot of light they seem to grow so strongly that they weaken their hosts considerably. Many of these hosts have died in the last five years. Where the host trees form a solid high canopy the mistletoe was found to be severely browsed by possums. This year, following two full seasons' management, the first flowers and fruit set occurred on these plants, even though plants in the open have produced copious quantities of flowers and fruit every year.

Ileostylus micranthus

As a result of following up old herbarium records this species was recently refound in the area, not because it had disappeared but only because DoC staff were unaware of its presence and the landowner did not know what it was! One host has died but many other species on the property have become infected and there seem to be no threats to the mistletoe's survival other than its very localised distribution — the grounds of a fishing lodge and the margins of some adjacent regenerating bush on private land, and occasional "gardening" by the lodge owner.

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Status of loranthaceous mistletoes in the East Coast Conservancy

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SUMMARY

Five species of leafy (loranthaceous) mistletoes are or were known from the East Coast Conservancy. These are: *Alepis flavida*, *Ileostylus micranthus, Peraxilla colensoi, P. tetrapetala* and *Tupeia antarctica*. The region is notable for the presence of large numbers (by North Island standards) of *Peraxilla* mistletoe within the beech forests of the Te Urewera National Park. However outside this area all species of leafy mistletoe are scarce, and some such as *Tupeia* are known only from widely scattered individuals or groups of plants.

1. INTRODUCTION

Within the land area administered by the East Coast Conservancy of the Department of Conservation, five species of loranthaceous mistletoes — *Alepis flavida*, *Ileostylus micranthus, Peraxilla colensoi, P. tetrapetala* and *Tupeia antarctica* — have been recorded. The beech forests of the region, especially the Raukumara and Te Urewera Ranges, were formerly well known for the abundance of beech mistletoes, particularly scarlet mistletoe (*Peraxilla colensoi*) (Ogle & Wilson 1985; A.P. Druce, pers. comm. 1993). Outside this area, herbarium records show that the common leafy mistletoes *Ileostylus* and *Tupeia* were locally common in the lowland mixed hardwood forests. Over the last thirty years the numbers of all five species of mistletoe have declined, such that neither of the *Peraxilla* mistletoes have been recently recorded from the Raukumara Range, while *Alepis*, last reported from the region by Tony Druce in the 1950s (pers. comm. 1993), is now believed locally extinct. Today, mistletoes of the genus *Peraxilla* remain locally common in some parts of the Te Urewera National Park, while the non-beech species *Ileostylus* and *Tupeia* are scarce.

King, D.R., de Lange, P.J. Status of loranthaceous mistletoes in the East Coast Conservancy. Pp. 43–45 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

2. STATUS AND PROTECTION MEASURES

The following briefly discusses the current (1995) status of the loranthaceous mistletoes reported from the East Coast Conservancy, the hosts utilised and the level of protection given to each species.

Alepis flavida (yellow mistletoe)

We have only verbal records of this species from the conservancy, no herbarium specimens from the region are known and, accordingly, the East Coast Conservancy is not included within the accepted herbarium distribution of the species (cf. de Lange *et al*. 1997). We retain the verbal record because the principal host tree for this species, black/mountain beech (*Nothofagus solandri* complex), is known from the area, and a number of early literature records suggest that *A. flavida* was at least locally present in the area until the mid 1950's (A.P. Druce, pers. comm. 1993; P.J. de Lange, unpubl. data). This species should be searched for in sites where the principal host tree has had a long-standing presence.

Ileostylus micranthus (green or scrub mistletoe)

This species occurs locally within the Motu, Pukeamaru, Tiniroto and Waikaremoana Ecological District's (McEwan 1987). Probably the single largest concentration occurs at Otoko and Rakauroa (Tiniroto Ecological District), where more than ten plants parasitise a wide variety of exotic hosts on private land. The landowner controls possum (*Trichosurus vulpecula*) levels in this area. At Lake Kiropukai, Te Urewera National Park, this species is locally common on small wooded islets, where it parasitises kohukohu (*Pittosporum tenuifolium*) and mingimingi (*Leucopogon fasciculatus*) (P.J. de Lange, unpubl. data).

Peraxilla colensoi (scarlet mistletoe)

This species remains locally common in parts of the extensive silver beech *(Nothofagus menziesii*) forests of Te Urewera National Park, especially on the possum-free islands of Lake Waikareiti. Other smaller populations occur at Mokau Landing and around Lake Waikaremoana. Lake Waikaremoana is the type locality for this species, where the first specimen (reputedly parasitising pohutukawa (*Metrosideros excelsa*)) was collected by Reverend William Colenso (Allan 1961). This host has not been recently confirmed from the area and it was more likely that the species parasitised was northern rata (*Metrosideros robusta*) as this species is common around the lake shore, and there is at least one more recent (c. 1930s) herbarium record recording a "tree" *Metrosideros* as a host for this mistletoe (P.J. de Lange, unpubl. data). Elsewhere in the East Coast region this species has been recorded as a single plant on a silver beech at Matawai, and there are historical records of scarlet mistletoe from the Pukeamaru Ecological District. The Matawai specimen is noteworthy because its flowers are heavily damaged each year by an unidentified species of geometrid moth (B.H. Patrick, pers. comm. 1995).

Peraxilla tetrapetala (red mistletoe)

Red mistletoe is locally common on silver beech in Te Urewera National Park, especially along the shore and islands of Lake Waikareiti. Elsewhere in the park occasional

specimens occur within the beech forest surrounding Lake Waikaremoana, and in the northern Urewera five plants were recently discovered parasitising tawheowheo (*Quintinia serrata*). Aside from the populations on the islands within Lake Waikareiti, all the other reported red mistletoe populations are receiving some level of possum control, including trapping and poisoning.

Tupeia antarctica (white mistletoe)

Probably the most threatened mistletoe species in the East Coast Conservancy. White mistletoe has recently been reported from only five sites, with only two localities supporting more than one plant. As this is a strictly dioecious species, its extinction at three of the known sites is therefore inevitable. At Lake Waikaremoana, protection measures in place include caging two of the mistletoe plants and localised possum control, with the subsequent result that 19 latent infections in surrounding host trees have resprouted. The host infected at this site is five finger (*Pseudopanax arboreus*), while elsewhere in the East Coast region the typical host is putaputaweta (*Carpodetus serratus*). At one site at Otoko (same site as for *Ileostylus*) 30 *Tupeia* are growing on tree lucerne.

3. THE FUTURE

Recent interest in non-beech mistletoes has resulted in the discovery of several populations of *Ileostylus* and *Tupeia*, previously unknown to the Department. Increased advocacy is planned and staff are requested to search for mistletoes while in the field.

4. ACKNOWLEDGEMENTS

The authors would like to thank Tony Druce for his comments on the former prescence of *Alepis flavida* within the Raukumara Range.

5. REFERENCES

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de Lange, P.J., Norton, D.A., Molloy, B.P.J. 1997. Historical distribution of New Zealand loranthaceous mistletoes. This volume, pp. 11–22.

Status of loranthaceous mistletoes in the Wanganui Conservancy

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SUMMARY

Five loranthaceous and three viscaceous mistletoes are present in the Wanganui Conservancy. Tables summarising their status and distribution are presented.

1. STATUS

Table 1 summarises the status of loranthaceous and viscaceous mistletoes within the Wanganui Conservancy (Fig. 1):

TABLE 1.

SPECIES (THREAT STATUS)	LOCATION IN WANGANUI CONSERVANCY	NO. OF PLANTS	HOSTS	STATUS
Ileostylus micranthus (Local)	Parapara Highway (Aberfeldy Hill)	c. 120	hawthorn (*Crataegus monogyna*)	increasing
	Junction Recreation Res. (Kimbolton)	c. 50	*Melicope simplex*, *Coprosma rigida*, *C. rotundifolia*	stable
	Near Egmont Nat. Park boundary (Norfolk Road)	1	*Coprosma* sp. 't'	
	Wanganui City (Mateongaonga Stream)	3	silver birch (*Betula pendula*), pear (*Pyrus communis*)	declining
	Pryces Bush near Rata	3	*Coprosma propinqua*	stable
	Geanges Road near Apiti	17	*Coprosma* sp 't', *Olearia virgata*	stable?
	Near Hunterville (not assessed)		Plane (*Platanus* sp.)	stable?

Barkla, J. and Ogle, C. Status of loranthaceous mistletoes in the Wanganui Conservancy. Pp. 47–49 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

SPECIES (THREAT STATUS)	LOCATION IN WANGANUI CONSERVANCY	NO. OF PLANTS	HOSTS	STATUS
Tupeia antarctica (Rare)	Mangaweka	2	kohuhu (*Pittosporum tenuifolium*), tarata (*P. eugenioides*)	declining?
	Kawhatau Valley	<5	tarata	declining?
	Moawhango	3	*Myrsine divaricata*	declining?
	Mataroa (NW Taihape)	<5	black maire (*Nestegis cunninghamii*),	declining?
	Mataroa – site 2	c. 8	putaputaweta (*Carpodetus serratus*)	increasing
	Ngamokai Road (Upper Whangaehu Valley)	c. 5	kohuhu (*Pittosporum tenuifolium*) *Myrsine divaricata*	?
Peraxilla tetrapetala (Vulnerable)	Westlawn Waiouru (Army Training Area)	c. 45	mountain beech (*Nothofagus solandri* var. *cliffortiodes*)	stable?
	North Waitaanga	3	hard beech (*Nothofagus truncata*)	declining?
Peraxilla colensoi (Vulnerable)	Waitaanga Conservation Area	4	silver beech (*Nothofagus menziesii*)	declining?
	SH 49 near Ohakune	3	silver beech	stable
Alepis flavida (Vulnerable)	Raetihi	2	mountain beech	stable?
	Waitaanga[1]	extinct?		

[1] A.P. Thompson in "New Zealand Man & the Biosphere Report No 2" 1979

2. MISTLETOE DISTRIBUTION

Table 2 summarises the occurrence of mistletoes in ecological districts of Wanganui Conservancy.

TABLE 2.

ECOLOGICAL DISTRICT / SPECIES	NT	EG	MA	FO	MP	RA	MO	TA	TO
Ileostylus micranthus		✓	✓		✓	✓			
Tupeia antarctica						✓			
Peraxilla tetrapetala	✓						✓		
Peraxilla colensoi	✓								✓
Alepis flavida	X								✓

(Ecological districts are: NT, North Taranaki; RA, Rangitikei; EG, Egmont; MO, Moawhango; MA, Matemateaonga; TA, Taumarunui; FO, Foxton; TO, Tongariro; MP, Manawatu Plains: ✓ Present: X Presumed extinct in ecological district)

FIGURE 1. DISTRIBUTION OF MISTLETOES IN WANGANUI CONSERVANCY.

Status of loranthaceous mistletoes in the Hawke's Bay Conservancy

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SUMMARY

Four species of leafy mistletoe (Loranthaceae) are reported from the conservancy. Public and media interest in the plight of mistletoes in the region is high, and as a result the conservancy is using mistletoes as "flagship" species advocating possum (*Trichosurus vulpecula*) control. Some vernacular names for mistletoes are suggested, as the conservancy has experienced some difficulty advocating the protection of these species without the use of "common names".

1. INTRODUCTION

Four species of leafy (loranthaceous) mistletoe, *Alepis flavida, Ileostylus micranthus, Peraxilla tetrapetala* and *Tupeia antarctica,* have been reported from the Hawke's Bay region. None of these are common, surviving only as highly fragmented populations within the region. Public interest in the conservation of these species is high, largely due to a very successful media campaign launched by the Hawke's Bay Conservancy.

2. SPECIES STATUS

Alepis flavida

Highly endangered. Known only from three widely separated sites in very small numbers at each: a tiny patch of trees in a farmer's paddock at Puketitiri (with good possum control); newly discovered at Boundary Stream Biodiversity Sanctuary and at Makahu Saddle. Hosts are red beech (*Nothofagus fusca*), black beech (*Nothofagus solandri* var. *solandri*) and mountain beech (*Nothofagus solandri* var. *cliffortioides*).

Ileostylus micranthus

Rare and vulnerable. Known in two localities. Only one site with reasonable numbers, a RAP for which protection is currently being sought. Hosts: horopito (*Pseudowintera colorata*), *Coprosma rubra*, pear (*Pyrus communis*) and totara (*Podocarpus totara*).

Walls, G. Status of loranthaceous mistletoes in the Hawke's Bay Conservancy. Pp. 51–53 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

Peraxilla tetrapetala

A flagship plant for the conservancy. Rare and vulnerable, but responding well to protective management. A few isolated individuals known from widely scattered sites in the Ruahine Forest Park, with monitoring but no special protection; a strong population splendidly nurtured and monitored at Little's Clearing-Makahu Saddle in the eastern Kaweka Forest Park, and a few individuals elsewhere in the park. Hosts: mountain beech and red beech.

Tupeia antarctica

Rare and vulnerable, though recovering well in response to protective management. Present at several localities in the conservancy, mostly in conservation areas with good possum control. Some caging. Hosts: five finger (*Pseudopanax arboreus*), putaputaweta (*Carpodetus serratus*) and tree lucerne (*Chamaecytisus palmensis*).

3. PUBLIC INTEREST

In the last five years, the Department of Conservation has picked up on the efforts of a few dedicated private individuals who have striven to protect the last remaining mistletoes. Through the publicity we have generated, there is growing public appreciation of the existence and status of mistletoes in Hawke's Bay. Now we have people volunteering to do searches for mistletoes, and a small local botanical group has got together to look for and help protect mistletoes and other rare plants. Local media (newspapers and radio) are supportive; so too are farmers and school children. I have produced a simple one page guide to the mistletoes to assist with public enquiries on their identification (Table 1).

TABLE 1. IDENTIFICATION GUIDE FOR MISTLETOES.

NAME	SIZE OF PLANT	LEAVES	FLOWERS	FRUIT	PLACES	HOSTS
Tupeia antarctica	Medium–large	Pale green, medium, kite-shaped	Green, small, spring-summer	White, pink or purplish, fleshy, autumn-spring	Lowlands, regenerating forest	Fivefinger, putaputaweta, tree lucerne
Ileosytlus micranthus	Medium–large	Yellow-green, large, oval	Green, small, spring-summer	Yellow, fleshy, summer-autumn	Lowlands, scrub and forest edges	Totara, *Coprosma*, horopito, marsh ribbonwood
Peraxilla tetrapetala	Medium–large	Medium, elong-ated, dark green	Red, showy, large, Christmas	Green, fleshy, early autumn	Lowland-upland beech forest	Mountain and red beech
Peraxilla colensoi	Medium–large	Large, oval, dark green	Red, showy, large, Christmas	Yellow, fleshy, early autumn	Lowland-upland beech forest	Silver beech
Alepis flavida	Medium–large	Medium, elong-ated, grey-green	Yellow, showy, large, New Year	Yellow, fleshy, autumn	Montane-upland beech forest	Red and mountain beech

4. CONSERVANCY ATTITUDE

Staff are pleased that mistletoes still exist in the conservancy and are interested in them. Field staff in particular have shown great enthusiasm and creativity in protection work. There has been no trouble getting the required resources for survey, protection and monitoring, and we have used the presence of mistletoes to justify a considerable amount of ecosystem protection work.

5. PROTECTIVE WORK

This has taken the form of:

1. Possum (*Trichosurus vulpecula*) control (trapping, cyanide, 1080, bait stations).
2. Caging (some innovative designs to keep possums out and let birds in).
3. Collaring trees.

6. PROPAGATION

We have repeatedly tried to "sow" seed of all species on a range of potential hosts in many sites. Despite good germination, not a single plant has established and grown so far. We have planted tree lucerne at one protected site of *Tupeia*, in the hope that the *Tupeia* will spread, thereby strengthening the population; in time we plan to follow up by planting longer-lived hosts on the site.

7. MONITORING

I have set up a system for monitoring most of the mistletoe populations in the Conservancy. I do most of the work myself, but am training field staff to take over.

8. VERNACULAR NAMES

It would be a great breakthrough for conservation and education if we could come up with and promulgate common-English or Maori names, that would have popular appeal, for each of the leafy mistletoes. Names already in use include:

scarlet mistletoe (*Peraxilla colensoi*)
red mistletoe (*Peraxilla tetrapetala*)
yellow mistletoe (*Alepis flavida*)
pirita (all the leafy species)
pirinoa (all the leafy species)
korukoru (*Peraxilla colensoi*)
pirirangi, pikirangi, (*Ileostylus micranthus, Peraxilla tetrapetala*)
papauma (*Ileostylus micranthus*)
roeroe (*Peraxilla tetrapetala*)
taapia, kohuorangi, tirau-riki (*Tupeia antarctica*)

Status of loranthaceous mistletoes in the Wellington Conservancy

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SUMMARY

Five species of loranthaceous mistletoe (*Alepis flavida, Ileostylus micranthus, Peraxilla colensoi, P. tetrapetala*, and *Tupeia antarctica*) have been reported from the conservancy. Records of these species have been stored within a Threatened Species Database and their former and current distributions have been mapped. Further surveys to determine the exact status and management requirements for each mistletoe is planned.

1. INTRODUCTION

Five species of loranthaceous mistletoe occur or were formerly known to occur in the Wellington Conservancy. The Wellington Conservancy mainland and island status of these five species (taken from the Wellington Conservancy Plant Conservation Strategy (Empson & Sawyer 1995)) is shown in Table 1 and is based on information available about these mistletoe species at the time of writing.

2. DISTRIBUTION

The former and current distribution of each of the five species of mistletoe listed in Table 1 are presented in Figure 1. Current records are observations

TABLE 1. CURRENT STATUS OF THE LORANTHACEOUS MISTLETOE TAXA.

TAXON	MAINLAND	ISLAND
Alepis flavida	Extirpated?	No records
Ileostylus micranthus	Endangered	Extirpated?
Peraxilla colensoi	Extirpated?	No records
Peraxilla tetrapetala	Endangered	No records
Tupeia antarctica	Endangered	Endangered

Sawyer, J. Status of loranthaceous mistletoes in the Wellington Conservancy. Pp. 55–57 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

FIGURE 1. DISTRIBUTION OF LORANTHACEOUS MISTLETOES IN WELLINGTON CONSERVANCY.

of extant populations made since 1985. These maps have been generated from information stored on the Wellington Conservancy Threatened Species Database. The database holds information from herbarium sheets, species lists, reports and publications and from information provided by botanists working in the region. These maps are not intended for use in the field. They merely illustrate what is currently known about the pattern of distribution of each mistletoe species. Details of the exact site location of these populations is stored on the Threatened Species Database. This site information may be obtained from the Wellington Conservancy office prior to undertaking a targeted field survey.

3. ABUNDANCE

For the loranthaceous mistletoe species known to be still extant in the Wellington Conservancy, information about the sites where the extant populations occur and the approximate number of individual plants at each site is summarised in Table 2.

TABLE 2. MISTLETOE SITES AND SPECIES STATUS FOR THE WELLINGTON CONSERVANCY.

TAXON	CURRENT SITES	NUMBER OF PLANTS PER SITE AND APPROXIMATE AGE CLASS
Ileostylus micranthus	Carter Scenic Reserve	2 (1 juvenile, 1 adult)
	Greytown Motor Camp	50+ (mixed population)
	Wainuioru River	3 juveniles
	Benge Park, Upper Hutt	c. 5 (mixed population)
	Mangatainoka	1 (1 moribund adult))
	Otaki River	5 (1 juvenile, 4 adult)
	Otaki	c. 9 (no details)
	Masterton (two sites)	1 (adult)
	Waikanae	c. 20+ (mixed population)
Peraxilla tetrapetala	Mt Holdsworth, Tararua	5 (5 adults)
	Te Marua Track, Kaitoke	1 (1 adult)
	Muritai, Eastbourne Hills	1 (1 adult)
	Kiriwhakapapa, Tararua	1 (1 adult)
Tupeia antarctica	Kapiti Island	11 (11 adult)
	Kouranui Stream (Wairarapa)	c. 50+ adults

4. FUTURE WORK

Further survey work is required to determine the current status of some populations of mistletoes that have not been observed in the last ten years. When this survey work has been completed the current status of the mistletoe species in the Wellington Conservancy may be determined more accurately. A campaign is planned to make the public aware of the Department of Conservation's interest in mistletoe sightings in the region. As a result of this campaign we expect to receive more new records of mistletoe sightings in the region. Work is also necessary to determine the most suitable management approaches that can be used to perpetuate populations of mistletoes.

5. REFERENCES

Empson, R.E., Sawyer, J.W.D. 1995. Wellington Conservancy Plant Conservation Strategy. Department of Conservation, Wellington, 80 p.

Status of loranthaceous mistletoes in the Nelson-Marlborough Conservancy

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SUMMARY

A mistletoe data base exists for the Nelson/Marlborough Conservancy and has been used to gain an understanding of the present distribution of each of the five loranthaceous mistletoe species, as well as their altitudinal range, range of hosts and habitats, and regional conservation status. Despite good documentation in the conservancy of possums contributing to mistletoe decline, it appears that there is no correlation between duration of possum occupation and persistence of mistletoes. This indicates that other factors are important in determining present mistletoe distribution and numbers.

1. DATABASE

The main activity our Conservancy is undertaking in relation to mistletoes is the maintenance of a mistletoe database which was initiated about five years ago along with a database of nationally threatened plants occurring in Nelson and Marlborough. Despite none of the mistletoes being on the threatened plants list at that time, the prime reason for starting the mistletoe database was because it was apparent, in the Conservancy at least, that the status of all mistletoe species ranged from uncommon to very uncommon and it seemed desirable to obtain some baseline information on them.

We have recorded the location and details of each population known in Nelson and Marlborough on a Conservancy mistletoe record sheet, detailing species, hosts, locality, grid reference, altitude, recorder, date and habitat, as well as observations on abundance, phenology, browse sign, and position on host. Field Centre staff and myself are the main contributors to the database, but the local botanical society has also been involved in data collection. So far, the information has only been stored as hard copy, but will be computerised once the Conservancy gets the GIS up and running.

To date, there are a total of 186 records of loranthaceous mistletoes, which break down to 79 of the three beech mistletoe species and 107 records of the two non-beech species.

Courtney, S. The status of loranthaceous mistletoes in the Nelson-Marlborough Conservancy. Pp. 59–65 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

2. DISTRIBUTION

Distribution maps (Figs 1 & 2) have recently been constructed by the conservancy on a scale of 1:250 000 from the grid reference information, and have been useful in revealing distribution patterns and key areas for each species, allowing distribution comparisons between species and providing a focus for continued survey. The following is a summary of the information contained in these maps.The distribution of the three beech mistletoes (Fig. 1) shows that these species are found mostly in the western parts of the Conservancy — especially around Nelson Lakes, the north-eastern parts of Northwest Nelson and in the Moutere depression.

FIGURE 1. DISTRIBUTION OF BEECH MISTLETOES IN THE NELSON-MARLBOROUGH CONSERVANCY.

FIGURE 2. DISTRIBUTION OF NON-BEECH MISTLETOES IN THE NELSON-MARLBOROUGH CONSERVANCY.

There are notable absences from much of the Marlborough and southern Northwest Nelson beech forests and not as many records from the beech forests on the possum free D'Urville and Arapawa Islands as one would expect.

Peraxilla colensoi is the most common of the three beech mistletoes, and *Alepis* and *Peraxilla tetrapetala* are the least common of the five mistletoes present in the Nelson-Marlborough area. Although *Alepis* is strongly centred on the southern Nelson beech forests, it is the most widespread of the beech species due to its persistence in the Kaikoura area. *Alepis* has not been found recently in Golden Bay or Marlborough Sounds, and *Peraxilla colensoi* has not been recently found in south Marlborough or the Marlborough Sounds.

The two non-beech mistletoes (Fig. 2) are more widespread than the beech species, occurring mainly in the coastal and lowland parts of Golden and Tasman Bays, the Sounds and south Marlborough. There are large gaps in the distribution of these mistletoes in Northwest and southern Nelson, Mt Richmond Forest Park and inland parts of south Marlborough.

Ileostylus is the most common of the five loranthaceous mistletoes, although it is absent from southern Nelson. *Tupeia* has not been found recently in Golden Bay but is the most common mistletoe on possum-free islands in the Marlborough Sounds.

3. SURVEY AND MONITORING

Although there has been no formal mistletoe survey in the Conservancy, the record sheet and database have provided a good focus to record any localities of mistletoes encountered during other field work. This is the main way the database has been built up. It has meant that coverage of the more accessible parts of the Conservancy, such as the lowland and coastal areas, has been more thorough than in the large forest tracts. Even so, given the large amount of time that is spent by field staff in the hinterland, the apparent lack of mistletoes in these areas is probably real.

Mistletoe monitoring has been confined to the beech species and is small scale, being restricted to a few sites in the St Arnaud and Takaka Field Centres where there is active management. A mistletoe transect set up in the early 1980s in Nelson Lakes National Park by Dr Peter Wilson of Ecology Division, DSIR is still operational and is an excellent baseline for further monitoring.

4. ACTIVE MANAGEMENT

There are two small active management programmes for mistletoe in the conservancy. The first has involved metal banding host trees of *Alepis* and both species of *Peraxilla* in the forest at the outlet to Lake Rotoiti in Nelson Lakes National Park. It was set up three years ago and the aim was to determine whether collaring mistletoe host trees in closed canopy forest had any effect in preventing browsing and improving mistletoe vigour. Monitoring has been undertaken by Jenny Ladley and results to date are inconclusive but they indicate that the bands are not preventing enough browse to allow an increase in mistletoe biomass.

The only other mistletoe management we are undertaking is using wire netting to enclose seven of 20 plants of *Peraxilla tetrapetala* on the Cobb ridge in Northwest Nelson. All the plants were small and severely browsed and within deer height when discovered. They were caged two years ago. Photo monitoring has shown an obvious increase in size, one of the seven has flowered since, and some of the uncaged plants have since died.

This Conservancy is setting up a mainland island restoration programme for a northern South Island honey-dew beech forest ecosystem. It will involve about 1000 hectares of mixed beech forest on the northeast side of Lake Rotoiti where there are already a few mistletoes, one of the aims being to increase mistletoe numbers back to pre-human densities.

Other large possum control operations in the Conservancy have been primarily for the recovery of the range of giant land snail species in Northwest Nelson and the Marlborough Sounds. Although mistletoes have been found only rarely in the drop areas, the operations probably have a beneficial effect on their recovery and expansion.

5. HOSTS (Table 1)

Peraxilla colensoi is the most host-specific mistletoe in the conservancy, being found only on silver beech. *Alepis* and *Peraxilla tetrapetala* are almost exclusively found on black and mountain beeches, but a small number are also found on red beech.

Ileostylus is the least host-specific, being found on 23 different hosts, the most common being *Coprosma propinqua*, totara and kanuka. *Tupeia* has 11 different hosts, the most common being tree lucerne, five-finger, akiraho and kohuhu. It is also recorded from weeping tree broom and kohekohe in the conservancy.

TABLE 1. MISTLETOE HOSTS, NELSON/MARLBOROUGH CONSERVANCY.

HOSTS	*P. colensoi*	*P. tetrapetala*	*Alepis*	*Ileostylus*	*Tupeia*
Silver beech	19	–	–	–	–
Black/mountain beech	–	16	10	–	–
Red beech	–	2	2	–	–
Coprosma propinqua	–	–	–	15	2
Tree lucerne	–	–	–	–	8
Five-finger	–	–	–	–	6
Totara	–	–	–	6	–
Kanuka	–	–	–	5	–
Akiraho	–	–	–	–	4
Kohuhu	–	–	–	–	4
Kowhai	–	–	–	4	–
Coprosma linariifolia	–	–	–	2	3
Coprosma crassifolia	–	–	–	3	–
Melicope simplex	–	–	–	2	–
Melicytus ramiflorus	–	–	–	2	–
Others	–	–	–	16	5

6. HABITAT (Table 2)

The most common habitat for *Peraxilla colensoi* and *Alepis* is a mixed beech forest of silver, red and black/mountain beeches. Although *Peraxilla tetrapetala* is also found in this habitat, it is most common in pure mountain beech forest.

Tupeia occurs mostly in coastal and lowland mixed broadleaf forest and in exotic stands of tree lucerne. *Ileostylus* is most frequent in estuarine shrublands but is also common in similar habitats to *Tupeia*.

TABLE 2 MISTLETOE HABITATS, NELSON/MARLBOROUGH CONSERVANCY.

HOSTS	*P. colensoi*	*P. tetrapetala*	*Alepis*	*Ileostylus*	*Tupeia*
Mixed beech	12	6	13	–	–
Mountain beech	–	11	1	–	–
Mixed beech-podocarp-broadleaf	4	–	1	3	2

Siver beech-broadleaf	2	–	–	–	–
Coastal mixed broadleaf forest	–	–	–	4	8
Exotic stands	–	–	–	3	7
Lowland mixed broadleaf forest	–	–	–	3	6
Esturine shrubland	–	–	–	8	–
Podocarp-broadleaf	–	–	–	5	–
Mountain totara-mixed broadleaf	–	–	–	–	2
Freshwater shrubland	–	–	–	2	–
Kanuka treeland	–	–	–	2	–
Sub-alpine shrubland	–	–	–	–	1
Solitary host in pasture	9	2	4	12	3

7. ALTITUDINAL DISTRIBUTION

Ileostylus is the most lowland of the five loranthaceous (leafy) mistletoes in Nelson and Marlborough (0–540 m), with most localities being below 50 m above sea level. *Peraxilla colensoi* is the next lowest altitude species (50–900 m), ranging from the lowland to lower montane zone but never coastal. *Alepis* and *Tupeia* have the widest altitudinal range. *Tupeia* is mainly a coastal and lowland species but is found rarely in upland forest and subalpine scrub (0–1200 m); while *Alepis* occurs on valley floor black beech in the lowlands but is more common on mountain beech at higher altitudes (70–1300 m). *Peraxilla tetrapetala* is the most upland of the five species and reaches the highest altitude (150–1320 m), with all but one record occurring above 600 m altitude.

8. THE POSSUM CONNECTION

There is little doubt that possums have contributed to the decline of mistletoe in the Conservancy, as the impact of possums in south Nelson has been well documented. Despite this, there is no obvious correlation between the duration of possum occupation of an area and the presence of mistletoes. One would expect higher mistletoe numbers where possums have only recently arrived or are still absent, and conversely no mistletoes where possum presence is long-standing. In fact, it appears that the opposite is the case, which indicates that other factors such as past mistletoe distribution and optimal habitat for mistletoes and possums, mistletoe habitat loss and possum-preferred species which are associated with mistletoe, are important in determining present distribution and numbers.

9. CONSERVATION STATUS

Based on the current numbers, rate of decline, habitat loss and possum threat I consider the conservation status of the loranthaceous mistletoes in the Nelson Marlborough Conservancy to fall in line with those of the 1995 Botanical Society listings:

Alepis flavida	vulnerable	(no refuge from possum)
Peraxilla colensoi	vulnerable	(no refuge from possum)
Peraxilla tetrapetala	vulnerable	(one known refuge from possum)
Tupeia antarctica	rare	(few refuges, range of hosts)
Ileostylus micranthus	local	(several refuges, range of hosts)

Past and present distribution of mistletoes on the West Coast

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SUMMARY

Historic records of abundant *Peraxilla colensoi* and *P. tetrapetala* and small but widely scattered extant populations in Buller and North Westland, together with the widespread and still abundant populations in the largely possum-free south Westland, suggest that these two species were once abundant in Buller and north Westland beech forests. *Ileostylus micranthus* also appears to have once been common in suitable habitats throughout the West Coast. There are only three early records of *Alepis flavida* and one of *Tupeia antarctica*. Since 1960, *Alepis* has been recorded from the Maruia Valley and from south Westland. *P. colensoi* and *P. tetrapetala* are currently known from 8 and 10 sites respectively in Buller and North Westland and remain abundant in south Westland. *I. micranthus* remains widespread throughout the West Coast lowlands but, with the exception of one population near Okarito, is generally in small populations. Loranthaceous mistletoes appear to be less abundant on the West Coast in areas with longer records of possum colonisation.

1. PAST (PRE-1960) DISTRIBUTION OF MISTLETOES ON THE WEST COAST

The only accounts of past mistletoe distribution on the West Coast of which I am aware are a few herbarium records and Townson's (1906) account of his wide-ranging botanical explorations of the "Westport district" (= Buller and North Westland) .

There are only three early records of *Alepis flavida*. Townson noted this species at Caroline Terrace (near Westport), as "parasitic upon *Fagus solandri* ... never found ... again in any other locality". CHR 60471 (W. MacKay, 9/1/1924) is annotated "Snowy River, Nelson", which appears to be the Snowy River near Waiuta, North Westland. WELT 31303 (B. Aston, no date) is annotated as "Vicinity of Greymouth".

Overmars, F. Past and present distribution of mistletoes on the West Coast. Pp. 67–70 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

Townson described *Peraxilla colensoi* as "common as a parasite on *Fagus*" in the Westport district, and also noted it up the Fox River ("scarlet masses pendant from limbs of *Fagus fusca*"). There are two herbarium records: CHR 60473, from Maimai near Reefton (MacKay, 27/12/1924), and CHR 63490 from the upper Haast valley (Ruth Mason, 26/12/1948).

Townson described *Peraxilla tetrapetala* as "abundant from sea-level to 2000 feet" in the Westport district (see also AK 3841). At Giles Creek near Westport, "*Fagus* ... trees (were) fairly ablaze with the scarlet flowers of *Elytranthe tetrapetala* in the early summer". At Blackwater Creek (Lower Buller Gorge), "scarlet blooms of *E. tetrapetala* provided the requisite touch of colour". MacKay's CHR 60470 (21/12/1924) is from Sewell Peak at the southern tip of the Paparoa Range. There is also an undated T. Kirk specimen from the Heaphy River (WELT 31310), which is annotated as "orange flowers variety".

In conjunction with the current widespread distribution of the two *Peraxilla* species in the still largely possum-free South Westland beech forests, and widely scattered but small extant populations in Buller and North Westland (see below), I consider these historic records strongly indicate that the two *Peraxilla* species were once widespread and abundant in the mixed beech forests of Buller and North Westland. *Alepis* was perhaps more sporadic: South Westland forests do not provide a guide because its principal hosts ("*fusca*" beeches) are largely absent there.

Townson recorded *Ileostylus micranthus* as "abundant throughout" the Westport district. There is a 1913 record from the Ngakawau River collected by D. Petrie (CANU 3513), a 1924 MacKay record (CHR 60469) from Boddytown near Greymouth, and a 1953 collection from "tidal creek at bridge on Carters Beach road" (CHR 81245, R. Mason). W.R.B. Oliver also collected this species in 1948 from Kotorapi, west of Greymouth. *Ileostylus* is currently the most widely distributed mistletoe species on the West Coast, although populations tend to be small and localised, and often associated with wet habitats unfavourable to possums. I suspect this species too was once considerably more abundant.

The only known West Coast record of *Tupeia antarctica*, historic or recent, is MacKay's CHR 60468 (5/10/1924), from Kamaka in the lower Grey Valley. This area is in the rain shadow of the Paparoa Range (<2000 mm per annum), the most similar on the West Coast to *Tupeia* habitats in Nelson and Canterbury, and is now largely converted to farmland.

2. PRESENT (POST-1960) DISTRIBUTION OF MISTLETOES ON THE WEST COAST

Since 1960, *Alepis* has been recorded in North Westland between Marble Hill, Lake Daniells and the Lewis Pass (G.&C. Kelly CHR 235670, Brian Molloy CHR 218909, Van Uden & Lamoureaux 1994, Overmars & Buckman 1995), and from the Moeraki Valley (Farrell & Mead 1989) and Cascade Valley (Peter Wardle CHR 311193, National Indigenous Vegetation Survey (NIVS) database, Manaaki Whenua). There are tens of plants at the Lewis Pass (Tarn Nature Walk), few or unknown numbers elsewhere. Hosts (where known) are primarily mountain and red beech. Colin Ogle (pers. comm.) holds a photo of *Alepis* on *Coprosma propinqua* in the Maruia riverbed (since swept away).

Peraxilla colensoi has been recently recorded in Buller and North Westland in small populations (sometimes single plants) at a number of sites in the Upper Maruia Valley-Lake Daniells area, and at Tiropahi Track (1 plant), Blackwater Ck (1), Maruia Saddle (2), lower Inangahua valley (3 scattered plants), Rahu Saddle (1), Clarke River (1), and Blackball (several). Several anecdotal records from other sites have yet to be confirmed. One local extinction event, at Rappahannock, has been recorded ("all plants in this stand have since died from unknown causes", Simpson 1976), about the time of possum colonisation (Pracy 1980). There is other evidence that North Westland populations are declining (Overmars & Buckman 1995). The species remains abundant in the silver beech forests of southern South Westland (Paringa southwards).

Peraxilla tetrapetala also occurs generally in very small populations or as single plants in Buller and North Westland: upper Waimangaroa valley (2–3 plants), Merrijigs (2), Globe Hill (4), Rahu Saddle (1), Lake Daniells track (1), Lake Daniells (5), Marble Hill (1), Rough Creek (8), Lewis Pass highway (1), and Lewis Pass summit (10–20 plants). Possum browse has been noted from some of these plants. Known hosts in Buller and North Westland are red, hard and mountain beech. In South Westland, the species is common where its distribution overlaps with the "*fusca*" group of beeches (cf. Wardle 1984); it also occurs to the north on silver beech where that is the only available host, but is less frequent there.

There are over 35 records of *Ileostylus* since 1960 from between Karamea and Jackson Bay. Populations generally range from one up to tens of plants, but are >1500/ha at Three Mile Lagoon near Okarito (Malcolm 1993). Habitats are mostly lowland estuaries, wetlands and low forest with poor soil drainage, plus the Refuge Islands in Lake Brunner and the Haast Visitors Centre. Nine hosts are known on the West Coast: *Coprosma propinqua, C. tenuicaulis, C.* sp. aff. *parviflora* (*C. parviflora* var. *dumosa* of Cheeseman 1906), *C. rhamnoides, Plagianthus divaricatus, Pittosporum colensoi, Sophora microphylla, Acacia melanoxylum,* and *Salix* sp. (cf. Norton *et al.* 1994).

Within Buller and North Westland, there appears to be a correlation between survival of *Peraxilla colensoi* and *P. tetrapetala* and recency of possum colonisation and/or habitat unsuitability (cf. Wilson 1984). Nearly all recent *Ileostylus* records are from habitats with wet soils or other habitat factors unsuitable to possums. The species tends to be more abundant in similar habitats in South Westland. The Upper Maruia valley, which supports the main extant populations of *P. colensoi*, *P. tetrapetala* and *A. flavida*, was colonised by possums as late as the 1970s (Pracy 1980). Only scattered plants of these species remain in areas in Buller and North Westland colonised before 1950. The recent possum invasion of the South Westland beech forests (Rose *et al*. 1993) potentially places the extensive leafy mistletoe populations there at risk.

Possums are not the only factor which may cause decline however. Four *Peraxilla tetrapetala* on pole red and hard beech at Globe Hill lie within a mining access arrangement with Macraes Mining Limited which permits the development of a large open cast mine. The agreement requires that the Company remove all species with an IUCN threat ranking to a place of safety. *Peraxilla tetrapetala* is currently listed as "Vulnerable" (Cameron *et al*. 1995). How the Globe Hill plants are to be protected is yet to be determined; establishment from seed appears to be the only option.

3. ACKNOWLEDGEMENTS

I thank Euan Nichol and Ralph Douglas of Manaaki Whenua, Lincoln for the provision of CHR and NIVS database records. David Norton provided non-CHR herbarium records.

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Status of loranthaceous mistletoes in the Canterbury Conservancy

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SUMMARY

Five loranthaceous mistletoes, *Alepis flavida*, *Ileostylus micranthus*, *Peraxilla colensoi*, *P. tetrapetala* and *Tupeia antarctica*, are present in Canterbury Conservancy. The three most common species appear to be *Alepis flavida*, *Ileostylus micranthus*, and *P. tetrapetala*, although this may reflect a greater survey effort in montane forest areas (largely Crown land) than in lowland scrub and forest remnants (many privately owned). The distribution and status of each species is addressed. At present no formal monitoring for mistletoe has been undertaken so any statement about the effect of possums on these species cannot be made.

1. INFORMATION SOURCES

Much of the information on mistletoe distributions are based on surveys in the 1970s and 1980s, although there is some more recent information (e.g, from PNAP surveys). Information on mistletoe abundance and distribution has been derived from several sources:

1. **NZFS and FRI Animal and Vegetation Surveys**. These are either based on recce plots or 20 x 20 m fixed plots and covered Crown forests in the main divide catchments and foothills. Records are made only for the plot locations along randomly located plot lines, with species seen between plots not recorded. No grid references were collected, although the physical location of the plot is plotted on reference maps. There is also some variability in observer skill/reliability in relation to the collection of information.
2. **PNAP Surveys**. PNA surveys have looked at 21 of the 60 ecological districts in the conservancy. The information obtained is variable and data is not easily searched. One major problem has been obtaining comprehensive coverage of the areas surveyed, as many sites are on private land and the conservancy has experienced access problems.

Baird, A. Status of loranthaceous mistletoes in the Canterbury Conservancy. Pp. 71–73 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

3. **Botanical Surveys and Other Publications**. With an active local botanical society and a large number of DSIR Botany Division, DSIR Land Resources and Landcare Research Ltd reports, much valuable information has been obtained on mistletoe distribution. Unfortunately much of this information is dated, some being over 20 years old (e.g., Kelly 1972).

2. SPECIES

Alepis flavida

Distribution

Widely distributed in locations which correspond to the range of black/mountain beech (*Nothofagus solandri*) forests. The species is primarily found in major catchments off the main divide (from Lake Tennyson to the Ahuriri River). Smaller scattered pockets exist within the beech clad foothills east of the divide between Oxford in the north and Mt Somers. Aside from these areas, *Alepis* has also been reported from Banks Peninsula, where it is probably now extinct. Elsewhere in the region several gaps occur within the stated distribution and these may relate to deficiencies in past surveys and the loss/absence of both host and habitat through land clearance.

Strongholds

The major strongholds for this species in the conservancy occur at Lake Sumner – Arthur's Pass/Craigieburn, in the vicinity of Lake Ohau and in the foothills and parts of Oxford forest. No quantitative information is available on the actual population size and density of *Alepis* in the region. However casual comments suggest that this species is "locally common", to "abundant" in large parts of its range within the conservancy.

Peraxilla colensoi

Distribution

Sparsely distributed within the conservancy mainly in the Lewis Pass, Wilberforce and Puketeraki areas. No information about this species density is available.

Peraxilla tetrapetala

Distribution

This species has a similar distribution to that of *Alepis flavida*, except that it is even more closely tied to the distribution of black and mountain beech. Several localities appear either to lack this species or have small sparsely distributed populations e.g., Rakaia, Rangitata, Lake Tekapo and Mt Cook. Some of these areas have experienced considerable beech forest clearance and in some cases mistletoe numbers have declined over the last thirty years. Based on the distribution map, the Lewis-Waiau-Hamner region also appears to have smaller than expected numbers of this species, reflecting in part a lack of baseline survey maps to allow plotting of the data.

Strongholds

Several of these exist, namely: South Hurunui/eastern Waimakariri and northern branches of the Rakaia, the Lake Ohau/Ahuriri area, and around the Ashley/Mt Thomas forests. As with *Alepis*, no quantitative assessments of this species abundance are available; however casual statements imply that it is "abundant" and "frequent" in large parts of its range. As a matter of interest, it has been observed (C. O'Donnell, pers.

comm. 1995) that yellowheads (*Mouhoua ochrocephala*) spent up to 20 % of their autumn feeding time on fruit of *Alepis* and *Peraxilla tetrapetala* (cf. Ladley & Kelly 1995).

Tupeia antarctica

Distribution

This species has a distribution primarily centred within lowland and coastal areas. However, it also occurs at high altitudes within the drier parts of the MacKenzie Basin, Lake Ohau and at Woolshed Hill (Arthur's Pass). Sites include Gore Bay, Conway Flat, Mt Cass and Hunter Hills.

Strongholds

The greatest densities occur on Banks Peninsula on both conservation and private land.

Ileostylus micranthus

Distribution

Widespread in lowland Canterbury (including Banks Peninsula) and common in north Canterbury coastal hills (especially Cheviot ED). Also present on south Canterbury foothills (Peel forest, Geraldine, Hunter Hills). Very few inland records, one from Lake Coleridge and also at Mt Hutt adjoining the plains. Appears to be common to abundant at most coastal sites where present.

3. THE FUTURE

At present no formal monitoring has been undertaken by the conservancy and so no clear indication of the effects of possums on mistletoe in Canterbury can be drawn. However, a preliminary survey of 83 *Peraxilla tetrapetala* plants along a river to bushline transect at Lake Ohau has shown that 70% of plants have dieback, with on average 30% of each plant dead. Definite browse was noted for 25% of plants. Repeat monitoring of this and establishment of further monitoring lines is required.

4. ACKNOWLEDGMENTS

I would like to thank Colin O'Donnell for his comments on the feeding behaviour of yellowheads.

5. REFERENCES

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Mistletoes in Otago

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SUMMARY

The distribution of mistletoes in Otago is not well documented, but from current information none of the eight species found here appear to be under threat. The three beech mistletoes are the most widespread, with two species being monitored for health and possum damage.

1. INTRODUCTION

Of the nine species of mistletoe in New Zealand, all except the presumed extinct *Trilepidea adamsii* are found in Otago. The beech mistletoes appear to be the most widespread and relatively common, but good records of distribution are not readily available. *Ileostylus micranthus* is common around the Lakes area and found along parts of the Otago coastal margin. The least common species appears to be *Tupeia antarctica*. It has only been recorded from the coastal areas. Distribution of the *Korthalsella* species is not well known but various species are found throughout Otago.

No systematic survey has been carried out so knowledge of mistletoe distribution is confined to herbarium records, reserve reports, species lists and personal knowledge. From this information it appears that mistletoes in Otago are not at present threatened, but none are particularly widespread although they may be locally common.

Monitoring of two species has been carried out over the last four to five years. At Waipori, on *Peraxilla colensoi* and in the Dingle Burn, where *Peraxilla tetrapetala* has been monitored for health and damage by insects and possums (see Appendix).

2. MISTLETOE DISTRIBUTION

Tupeia antarctica is relatively common around Dunedin, particularly on exotic trees. It has been recorded on *Robinia* along the Leith River and on *Carpodetus* in the town belt. It occurs at Goodwood Scenic Reserve near Palmerston, and in the Waianakarua area, also from around Balclutha (Peter Johnson, pers. comm.).

Ileostylus micranthus is recorded from several coastal areas, the Catlins, Dunedin and Palmerston and from around the Lakes where it is quite abundant, growing on a wide range of hosts, both native and exotic. It is perhaps significant that it is not found far away from the Lakes and their regenerating shrubland fringes where these large bodies of water have a modifying influence on the climate.

Simpson, N. Mistletoes in Otago. Pp. 75–78 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

Alepis flavida is the most common of the beech mistletoes. It occurs primarily on mountain beech and is found wherever this species occurs in Otago. It is also occasionally found on silver and red beech. On Pigeon Island in Lake Wakatipu, there are several very large clumps of *Alepis* growing on mature red beech. At Sunshine Bay, Queenstown, *Alepis* is found on mountain and red beech, and on *Coprosma propinqua*. *Alepis* is recorded from Mt Aspiring National Park, Lakes Wakatipu, Wanaka and Hawea, Eyre, Thomson, Garvie, Hector, Remarkable and Umbrella mountains as well as in the Catlins and Dunedin areas.

Peraxilla colensoi is found in silver beech forests in the Maungatuas (Waipori), Tapanui, Catlins area, Tuapeka, Silver Peaks (near Dunedin), Lakes Wakatipu, Wanaka and Hawea (Dingle Burn and Hunter Valleys). It is common in the Mount Aspiring National Park. Some possum damage has been recorded.

Peraxilla tetrapetala has few records and is not mentioned in "The Vegetation of Mount Aspiring National Park" although it does occur there. It is quite common around Lake Hawea (up adjacent valleys) and has been recorded from the Eyre Mountains and Dart Valley. There is a large population on mountain beech along the road to the Routeburn track, around the Lake Sylvan turn-off. A record from Pigeon Island, Lake Wakatipu is *Alepis flavida*, with which it can be easily confused when not in flower.

3. MONITORING

Since 1991, twenty-two *Peraxilla colensoi* plants have been monitored regularly (using binoculars) in the Waipori area. Plant health has been recorded using a one to five scale, five being very healthy and one nearly dead. A brief description and sketch has been made of plants and any damage by insects or possums noted. Possum sign from the surrounding forest is also noted. No significant possum damage has occurred in this time and most plants have consistently registered a four or five. The forest is mixed silver beech/broadleaf/podocarp with a good variety of plant species.

In the Dingle Burn, John Fleming has been monitoring *Peraxilla tetrapetala* (see Appendix 1).

4. THREATS

From the records and from discussion with various people, it appears that mistletoes in Otago are surviving quite well with little change to their numbers or distribution. Habitat loss is a threat but most records come from protected areas. Possums are a threat in some forests.

5. DISCUSSION

Apart from the two areas being monitored, knowledge of the status of the eight species of mistletoe is not great, especially by DoC staff. Some survey and further monitoring would be useful. Circulating all Field Centres with illustrations, information and recording forms and informing the public is one way of gaining more information.

6. APPENDIX 1. DINGLE VALLEY MISTLETOE (*Peraxilla tetrapetala*) SURVEY 1992–1995

This work was undertaken in the Dingle Valley, which drains into Lake Hawea. The survey area is mid-altitude forest between 350 m and 750 m, and is typical dry mountain beech with a northerly aspect. 21 trees were tagged, of which 11 were immature or juvenile plants and ten mature (flowering) plants. The survey was initiated because of a decline in recent years of some birds (e.g., parakeets and bellbirds). Two trees were also collared and mistletoes on these were the only ones to flower during the last two seasons.

There was also obvious possum damage in the area, with the ten mature plants suffering serious over-browsing. Leaf and shoots were eaten, resulting in no flowering. The 11 immature plants suffered minimal damage from both possums and insects. Four mistletoe plants were killed by territorial bark biting, especially on the larger plants where possums could move around freely. Possums utilised mistletoe as a food source from mid-May until September, especially when snow covered the tussock lands which are the main source of food in the Dingle.

The area surveyed was heavily used by possums during the winter months. A localised poison operation followed by trapping in 1994 has resulted in no further damage to mistletoe plants, but also no obvious recovery. 320 possums were killed. A bird survey of the area is currently being carried out.

The rest of the Dingle's mistletoe are used as a food source but not to the same extent as the monitoring site, especially on the colder southerly slopes where possum numbers are not so high.

Both *Peraxilla tetrapetala* and, to a lesser extent, *P. colensoi* are present in the Hunter, Matukituki and Makarora forests. These predominantly silver and red beech forests have far more palatable and varied food sources than simple mountain beech forest, so the mistletoe has had only minimal browsing. The exceptions are where there are small patches of trees isolated from the main forest which is used as a play or communal meeting place for possums.

The common mistletoe (*Ileostylus micranthus*) is present on the three main islands on Lake Wanaka. Hosts to this mistletoe on Stevensons Island are briar, an apple tree, manuka and kanuka.

Information recorded on mistletoe survey form

1. Species red mistletoe (*Peraxilla tetrapetala*)
2. Host tree (mountain beech)
3. Height from ground
4. Photo number
5. Scale 0 all leaves present → Scale 5 all leaves absent
6. Tree tagged
7. Date
8. Leaf or branches of mistletoe at base of tree record
9. Notes general

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Status of loranthaceous mistletoes in the Southland Conservancy

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SUMMARY

Five species of mistletoe, *Alepis flavida, Ileostylus micranthus, Peraxilla colensoi, P. tetrapetala* and *Tupeia antarctica,* are known from the area administered by Southland Conservancy. There is some evidence to suggest that possum browse is damaging some of mistletoe populations. A brief review of the distribution and status of each species is given.

1. INTRODUCTION

Five of the seven loranthaceous mistleote species — *Alepis flavida*, *Ileostylus micranthus*, *Peraxilla colensoi*, *P. tetrapetala* and *Tupeia antarctica* — are present in Southland Conservancy. The effect of possums appears to be substantially less than in other parts of New Zealand, and it is not uncommon to find large plants of *Peraxilla colensoi* with branches >1 m long. There is, however, some evidence of browsing by possums and the effect of this is currently being monitored in the Eglinton Valley.

2. SPECIES

Peraxilla colensoi

Peraxilla colensoi is the commonest mistletoe species in Southland, being recorded from the Blue Mountains in the east to the fiords in the west. More than 20 site record forms have been completed for this species with most populations comprising c. 20 plants but one population with > 200 plants. There is no doubt that many more sites exist than are currently recorded. At most sites, damage by possums appears to be minimal.

Peraxilla tetrapetala

Peraxilla tetrapetala is known from six sites from the eastern Longwoods to eastern Fiordland. It is often, but not always, found in association with

Rance, B.D. & West, C.J. Status of loranthaceous mistletoes in the Southland Conservancy. Pp. 79–80 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

P. colensoi and is probably best described as threatened within the Conservancy. At most sites there appears to be some damage by possums.

Alepis flavida

Alepis flavida has been recorded from eight sites in eastern Fiordland, from Lake Monowai through to the Eglinton Valley. The species is locally abundant at each site. Possums appear to be having some impact locally and the species may be declining in Southland.

Ileostylus micranthus

Ileostylus micranthus is the most widespread species, being recorded from lowland and coastal sites from Stewart Island and Whenua Hou and eastern Southland to Port Craig on the South Coast. The species could possibly be regarded as threatened as it is not abundant at any one site. The effect of possums is unknown.

Tupeia antarctica

Tupeia antarctica is the least common of all the mistletoe species in Southland, being recorded from four sites only. At some sites many individuals are present but at others there are just a few. Some sites have evidence of possum browsing.

3. GENERAL COMMENTS

Southland may be one of the strongholds for *Peraxilla colensoi* in New Zealand and may be on the edge of the major range of *Alepis flavida*. Although populations of all species appear healthy at present, they may be declining, and monitoring of some populations is warranted.

Part 2 Ecology of New Zealand mistletoes

An annotated checklist of New Zealand mistletoe (Loranthaceae) hosts

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SUMMARY

A revised checklist of hosts for New Zealand loranthaceous mistletoes (updated to 14 February 1997) is presented. Records are arranged by the level of confidence attached to them. The preferred record is a herbarium specimen showing both mistletoe and host mounted on the same sheet. It is recommended that for future analyses of host specificity, only those records verified in this manner should be used. The numbers of hosts parasitised by the various species and verified are: *Alepis flavida* (9 taxa), *Ileostylus micranthus* (196 taxa), *Peraxilla colensoi* (3 taxa), *P. tetrapetala* (13 taxa), *Muellerina celastroides* (0 taxa), *Trilepidea adamsii* (1 taxon) and *Tupeia antarctica* (33 taxa).

1. INTRODUCTION

This list updates and follows those published by Norton *et al*. (1994) and de Lange *et al*. (1996). Our purpose in publishing a revised list is twofold; firstly, it introduces new records received from the New Zealand botanical community, secondly, it provides a breakdown of the exact nature of each host record, thereby furnishing a measure of the accuracy of each record.

The need for caution became evident when various literature records cited by Norton *et al*. (1994), and some personal communications of host attachments received from the botanical community proved erroneous.

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de Lange, P.J., Norton, D.A., Molloy, B.P.J. An annotated checklist of New Zealand mistletoe (Loranthaceae) hosts. Pp. 83–104 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

2. THE LIST

The following checklist (Appendix) of hosts for New Zealand loranthaceous mistletoes is arranged according to the degree of confidence for each host listed:

1. host verified by a herbarium specimen and/or clear photograph mounted alongside the mistletoe (Fig. 1);
2. personal communication from a reliable source;
3. host mentioned but not verified on herbarium sheet;
4. literature record.

Following Norton *et al*. (1994) and de Lange *et al*. (1996), this list does not include a breakdown of the hosts of New Zealand species of *Korthalsella* (Viscaceae), because these are in a different family and, as such, are the subject of future research by the authors.

Hosts are arranged alphabetically by family, genus and species (including hybrids) for each mistletoe species. A breakdown of the numbers of indigenous and exotic taxa parasitised is also given. Norton *et al*. (1994) and de Lange *et al*. (1996) highlighted the danger of accepting hosts without verifiable proof of parasitism. Accordingly, while we list all the hosts reported to us, based on herbarium specimens and the botanical literature, we emphasise that only those records supported by *actual* evidence of the host utilised (Fig. 1) be accepted as valid records.

The least satisfactory of all the host categories presented are Literature Records. In the course of our research for this publication we have observed how many of these records are merely duplications of earlier and often dubious observations made before the turn of the century. Therefore we have tried (where possible) to record the original source for each literature record, and we would stress that no record should be accepted as fact until such time as it is supported by an actual and unequivocal herbarium voucher. We also urge current authors to verify their records to prevent future confusion.

A more detailed interpretation of the level of host specificity demonstrated by our loranthaceous mistletoes is in preparation (D.A. Norton & P.J. de Lange, unpubl. data), however some preliminary analyses are given below. While this list is more comprehensive than those of Norton *et al.* (1994) and de Lange *et al*. (1996), it is still far from complete, with many host records not validated with vouchers. For this reason we invite all list users to verify those records presently lacking an appropriate herbarium voucher. We are also interested to receive any host records additional to those listed, especially if they are supported with an appropriate voucher (Fig. 1).

This list is revised up to 14 February 1996 and further updates are intended. Nomenclature of mistletoes and host taxa follows that suggested by Simpson & Thomson (1942), Cooper (1956), Allan (1961), Barlow (1966), Connor & Edgar (1987), Druce (1993), Heenan (1995), Garnock-Jones and Elder (1996), and Molloy (1996) for indigenous taxa, and that of Webb *et al*. (1988), Huxley *et al*. (1992), and Tutin *et al*. (1993) for exotics. Herbarium acronyms and other minor nomenclatural decisions follow those recommended by Holmgren *et al*. (1990), and the ICBN (Greuter *et al*. 1994). An * denotes an exotic taxon.

FIGURE 1. HERBARIUM SPECIMEN SHOWING A COLLECTION OF THE GREEN MISTLETOE (*Ileostylus micranthus*) AND ITS HOST TOTARA (*Podocarpus totara*).

3. PRELIMINARY ANALYSIS

The following analysis provides some interim results of the numbers of taxa reported as hosts for New Zealand loranthaceous mistletoes. As noted above, only those host records verified by an appropriate voucher should be used for critical analyses.

Alepis flavida

Alepis is recorded from 13 hosts (all indigenous), in 6 genera, and 6 families. At present 9 of the 13 recorded hosts have been verified by an appropriate herbarium voucher.

Ileostylus micranthus

Ileostylus, of all the indigenous New Zealand loranthaceous mistletoes, is the least host specific. Including its Norfolk Island hosts, *Ileostylus* has been recorded parasitising 209 taxa (114 indigenous, 92 exotic and 3 confined to Norfolk Island), in 100 genera and 51 families. Currently, 196 host taxa have been verified by a herbarium voucher. Although a more detailed analysis of host preference is being prepared (Norton and de Lange, unpubl. data), the most favoured (10 or more taxa utilised) host families for *Ileostylus* (with numbers of taxa parasitised included in brackets) are: Asteraceae (10), Fabaceae (18), Oleaceae (11), Rosaceae (21), Rubiaceae (24) and Violaceae (10). Of these families the Oleaceae is thus far unique in that no indigenous representatives are parasitised.

Muellerina celastroides

The indigenous status of this taxon is presently being reviewed by one of us (BPJM). Available information on host preferences from the only authentic New Zealand collections known, imply that the host was an indigenous species of *Metrosideros,* probably pohutukawa (*M. excelsa*). This host record is not substantiated by a herbarium voucher.

Peraxilla colensoi

Peraxilla colensoi has been recorded utilising 16 host taxa (9 of these exotic) within 12 genera and 7 families. However, only 3 hosts are verified by a herbarium voucher and, as many of the reported hosts are based on old (pre 1930) literature records, their authenticity is considered suspect.

Peraxilla tetrapetala

Unlike *P. colensoi*, *P. tetrapetala*, a more widespread species, has been confirmed from a much wider selection of host taxa. In this paper we record the species parasitising 17 species (2 of these exotic), in 11 genera and 11 families. Of these records, 13 are verified by a herbarium voucher.

Trilepidea adamsii

Recorded parasitising 4 species, in 3 genera and 3 families. Only one host, *Coprosma arborea*, is supported by a herbarium voucher. As with *Peraxilla colensoi*, available literature records are old and possibly unreliable. We provisionally accept only one other host — *Myrsine australis* — because this was specifically mentioned on a herbarium specimen, collected by a reliable source — Donald Petrie.

Tupeia antarctica

After *Ileostylus*, *Tupeia* parasitises the next greatest number of hosts. At present we record *Tupeia* from 48 hosts (11 exotic), spread through 32 genera and 20 families. However, only 33 host taxa are verified by an appropriate voucher, and at least one literature record, an instance of *Tupeia* parasitic on *Ripogonum scandens* (Smart 1952), is considered extremely doubtful. Of the 48 recorded hosts, the most favoured families (5 or more taxa utilised) parasitised by *Tupeia* (with numbers of hosts utilised given in brackets) are the Fabaceae (9) and Rubiaceae (6).

4. *Ileostylus* AND *Tupeia* HYBRIDS

Thomson (1949) briefly discussed and illustrated a putative hybrid mistletoe, *Ileostylus micranthus* x *Tupeia antarctica*, based on collections made from a specimen parasitising a cultivated plant of *Coprosma chathamica*. Thomson considered his plant was this hybrid because of the leaf shape (the paper includes some poor illustrations of these), and apparent differences in the reproductive behaviour of the plant. Allan (1961) included Thomson's observations under his entry for *Tupeia* but without adding further comment. Barlow (1966) dismissed the hybrid as part of the natural range of variation within *Tupeia antarctica*. More recently, Norton *et al*. (1994) considered the hybrid may have been an example of double parasitism between *Tupeia* and *Ileostylus*, an observation supported by the fact that both genera frequently parasitise each other in some parts of the country e.g., Banks Peninsula. Unfortunately, no herbarium specimens of Thomson's putative hybrid exist, so an assessment based on tangible evidence is impossible. However, following a critical reappraisal of the observations made by Thomson (1949), we support Barlow's earlier suggestion that the putative hybrid was *Tupeia*. We have come to this view through our combined experience of the range of leaf sizes, fruit shape and colouration exhibited by *Tupeia*. We have also observed that in many wild populations of *Tupeia* both sexes frequently become intermingled, such that it is often difficult to distinguish separate plants. The fact that Thomson did not observe functionally perfect flowers but rather that "one branch produced male flowers only" while the rest of the "plant" was female, suggests that he had two plants, male and female, growing on the same host. This is further suggested by his later observations that seedlings raised from his "hybrid" were either "male or female". We can also add that no further hybrids between these mistletoe genera or indeed between *Alepis* and *Peraxilla* as was suggested by Cockayne & Allan (see Allan 1961:415) have been reported or revealed through our herbarium searches. Indeed, based on their chromosome numbers and karyotypes, hybrids between any of our indigenous mistletoe genera are considered extremely unlikely (Beuzenberg & Groves 1974; B.P.J. Molloy, unpubl. data). For all these reasons, *Coprosma chathamica* is listed as a host for *Tupeia antarctica*.

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7. APPENDIX 1. ANNOTATED LORANTHACEOUS HOST LIST.

Record categories: 1. Host verified by a supporting voucher specimen or clear photograph lodged alongside mistletoe voucher; 2. Host reported by a reliable source; 3. Host mentioned on herbarium sheet; 4. Literature record.

* denotes an exotic taxon.

TABLE 1. HOSTS OF *Alepis flavida*.

MISTLETOE SPECIES	HOST FAMILY	HOST GENUS	HOST SPECIES	RECORD CATEGORIES			
				1	2	3	4
Alepis flavida							
	Araliaceae	*Pseudopanax*	*P. colensoi* var. *colensoi* *P. colensoi* var. *ternatus*	 AK 229052		WELTU 8750	
	Elaeocarpaceae	*Aristotelia*	*A. fruticosa*		B.P.J. Molloy (pers.obs.)		
	Epacridaceae	*Archeria*	*A. traversii*	WELT 44861			
	Fagaceae	*Nothofagus*	*N. fusca* *N. menziesii* *N. solandri* var. *cliffortioides* *N. solandri* var. *solandri* *N. truncata* *N. fusca* x *N. solandri* var.*cliffortioides*	CHR 218909 CHR 201504 CHR 201504 AK 222049		 CHR 73406 WELT 31311	
	Myrsinaceae	*Myrsine*	*M. divaricata*	AK 229053			
	Rubiaceae	*Coprosma*	*C. pseudocuneata* s.str. *C. propinqua*	NZFRI 20319 AK 221707			
Totals	**6**	**6**	**13**	**9**	**1**	**3**	**0**
	Indigenous Exotic	4 0	13 0	9 0	1 0	3 0	0 0

TABLE 2. HOSTS OF *Ileostylus micranthus*.

MISTLETOE SPECIES	HOST FAMILY	HOST GENUS	HOST SPECIES	RECORD CATEGORIES			
				1	2	3	4
Ileostylus micranthus							
	Aceraceae	**Acer*	**A. negundo* **A. palmatum* **A. pseudoplatanus* **A.* sp.	AKU 18609 AK 224603 AK 222053 AK 224030			
	Araliaceae	**Hedera* *Pseudopanax*	**H. helix* *P. anomalous* *P. arboreus* *P. crassifolius* *P. ferox* *P. simplex*	AK 222402 AK 223954 AK 222388 AK 223929 AK 223955			Wilson (1982)
		Schefflera	*S. digitata*	AK 222392			
	Asteraceae	*Cassinia* *Helichrysum* *Pachystegia* *Olearia*	*C. leptophylla* *H. aggregatum* *H. intermedium* var. "tumidum" *P. insignis* *Olearia angulata* *O. hectorii* s. str. *O. ilicifolia* *O. paniculata* *O. solandri* *O. virgata*	AK 230697 AK 222038 AK 221724 AK 227265 AK 222419 AK 227652 AK 223938 AK 223947 AK 231007		AK 226536	
	Betulaceae	**Alnus* **Betula* **Corylus*	**A. glutinosa* **B. pendula* **C. avellana*	AK 223946 AK 223395 CHR 286197			
	Caprifoliaceae	**Lonicera* **Viburnum*	**L. nitida* **V. tinus*	AK 224594 AK 223956			
	Celastraceae	**Euonymus*	**E. japonicus*	AK 223735			
	Cornaceae	**Dendrobenthamia*	**D. capitata*	AK 223497			
	Cupressaceae	**Cupressus*	**C. macrocarpa*	AK 221696			
	Elaeagnaceae	**Elaegnus*	**E.* x*reflexa*	AK 223802			
	Elaeocarpaceae	*Aristotelia*	*A. fruticosa*		B.P.J. Molloy (pers. obs.)		

		Elaeocarpus	*A. serrata* *E. dentatus* *E. hookerianus*	AK 222389 AK 222390 CHR 94065			
	Epacridaceae	*Cyathodes* *Leucopogon*	*C. juniperina* *L. fasciculatus*	CHR 417069 AK 230998			
	Ericaceae	**Arbutus* **Erica* *Gaultheria* **Rhododendron*	**A. andrachne* **A. unedo* **E. arborea* **E. lusitanica* *G. antipoda* **R. ponticum* **R.* sp. **R.* cv 'Kurume hybrids'	AK 230484 AK 224280 CHR 499557 AK 222415 AK 222046 AK 222413 CHR 286157 AK 225894			
	Escalloniaceae	*Carpodetus* *Corokia*	*C. serratus* *C. cotoneaster* *C.* x*virgata*	AK 230987 CHR 28178 AK 266095			
	Fabaceae	**Acacia* *Carmichaelia* **Chamaecytisus* **Cytisus* **Laburnum* **Lupinus* **Robinia* *Sophora* **Ulex* **Virgilia*	**A. baileyana* **A. dealbata* **A. mearnsii* **A. melanoxylon* **A. parramattense* *C. australis* *C. petriei* **C. palmensis* **C. scoparius* **L. ?anagyroides* **L. arboreus* **R. pseudacacia* *S. longicarinata* *S. microphylla* s.l. *S. prostrata* *S. tetraptera* **U. europaeus* **V. divaricata* x *V. oroboides*	AK 222416 CHR 286198 AK 225893 AK 226814 AK 226093 WELT 31057 AK 222035 CANU 18912 AK 222041 AK 223927 AK 223935 AK 223945 AK 230992 CANU 36584 CANU 36582 AK 222401 AK 221699 AK 231006			
	Fagaceae	**Quercus*	**Q. cerris* **Q. ilex* **Q. palustris* **Q. robur* **Q. suber*	AK 224596 AK 224906 AK 224911 AK 222385 AK 224907			
	Griseliniaceae	*Griselinia*	*G. littoralis*	CANU 16943			
	Grossulariaceae	**Ribes*	**R. sanguineum*				Bannister (1989)
	Hamamelidaceae	**Liquidamber*	**L. styraciflua*	AK 223943			

	Icacinaceae	*Pennantia*	*P. corymbosa*	AK 222054			
	Lamiaceae	**Rosmarinus*	**R. officinalis*	AK 230699			
	Lauraceae	*Beilschmiedia*	*B. tawa*			NZFRI 5392	
	Loranthaceae	*Tupeia*	*T. antarctica*	AK 222398			
	Magnoliaceae	**Liriodendron*	**L. tulipifera*	CHR 286191			
	Malvaceae	*Hoheria* *Plagianthus*	*H. angustifolia* *H. populnea* *H. sexstylosa* *P. divaricatus* *P. regius*	AK 223940 AK 222410 CHR 286208 AK 221700 AK 223787			
	Moraceae	**Ficus* *Streblus*	**F. carica* *S. heterophyllus*	AK 224604 AK 224922			
	Myoporaceae	*Myoporum*	*M. laetum*	CHR 286152			
	Myrsinaceae	*Myrsine*	*M. australis* *M. divaricata*	AK 222043 AK 223937			
	Myrtaceae	**Eucalyptus* **Callistemon* *Kunzea* *Leptospermum* *Lophomyrtus* *Metrosideros* *Neomyrtus*	**E.* sp.?*pseudoglobulus* *C. rigidus* *K. ericoides* var. *ericoides.* *K. ericoides* var. *linearis* *L. scoparium* *L. bullata* *L. obcordata* *M. robusta* *M. umbellata* *N. pedunculata*	 AK 229834 CANU 36909 AK 225889 CHR 353612 AK 222383 AK 200873 AK 229054 AK 222039 AK 222521	G.T. Jane (pers. comm. 1994)		
	Oleaceae	**Forsythia* **Fraxinus* **Ligustrum* **Osmanthus* **Syringa*	**F.* x*intermedia* **F. suspensa* **F. angustifolia* subsp. *oxycarpa* cv. “Raywoodii” **F. excelsior* **F. ornus* **F.* sp. ?*pennsylvanica* **L. sinense* **L. ovalifolium* **O. fragrans* **O. heterophyllus* **S. vulgaris*	CHR 286197 AK 229835 AK 222386 AK 222406 AK 222517 AK 224914 AK 223734 AK 224029 AK 229836 CHR 439521 AK 222394			

	Onagraceae	*Fuchsia*	*F. excorticata* *F. perscandens* *F. excorticata* x *F. perscandens*	CANU 16939 AK 222383	B.P.J. Molloy (pers. obs.)		
	Pinaceae	**Pinus*	**P. muricata* **P. radiata*	NZFRI 840 AK 222378			
	Pittosporaceae	*Pittosporum*	*P. bracteolatum* (Norfolk Island) *P. crassifolium* *P. ellipticum* *P. eugenioides* *P. ralphii* *P. tenuifolium* subsp. *colensoi* *P. tenuifolium* subsp. *tenuifolium*	AK 223933 CHR 286206 AK 226097 AK 222399	G. Platt (pers. comm. 1994) F.B. Overmars (pers. comm., 1995)	CHR 229838	
	Platanaceae	**Platanus*	**P.* x*acerifolia*	AK 224032			
	Phyllocladaceae	*Phyllocladus*	*P.* aff. *alpinus*	AK 229051			
	Podocarpaceae	*Dacrycarpus* *Dacrydium* *Halocarpus* *Podocarpus* *Prumnopitys*	*D. dacrydioides* *D. cupressinum* *H. biformis* *Podocarpus hallii* *P. totara* *P. taxifolia*	AK 221702 WAIK 4936 AK 230991 OTA 36288 CHR 461059 AK 224918			
	Polygonaceae	*Muehlenbeckia*	*M. australis* *M. complexa*	AK 221701 AK 221697			
	Proteaceae	**Embothrium* *Toronia*	**E. coccineum* *T. toru*	WELT 31285	P.J. de Lange (pers. obs.)		
	Rhamnaceae	*Discaria*	*D. toumatou*	AK 222040			
	Rosaceae	**Cotoneaster* **Crataegus* **Eriobotyra* **Malus* **Photinia* **Prunus*	**C. simonsii* **C. monogyna* **E. japonica* **M.* x*domestica* **M. baccata* x *M.* x*domestica* **P. serrulata* cv. “Red Robin” **P. cerasifera* **P. laurocerasus* **P. persica* **P. serrulata*	AK 222034 CHR 219687 AK 224601 CHR 286192 AK 222541 AK 224930 CHR 286158 AK 222515 AK 224031 AK 222407			

		*Pyracantha *Pyrus *Rosa	*P. xdomestica *P. angustifolia *P. communis R. chinensis cv.	CHR 286202 AK 222404 CHR 286157	J. Mason (pers. comm. 1995)		
		Rubus† *Sorbus	*R. rubiginosa R. australis R. cissoides *R. fruticosus agg. R. schmidelioides R. squarrosus *S. aucuparia	CHR 286170 CANU 37223 AK 222052 AK 222403 AK 223953 AK 223930 CHR 286190			
	Rubiaceae	Coprosma	C. areolata C. ciliata C. crassifolia C. foetidissima C. grandiflora C. linariifolia C. lucida C. sp. aff. macrocarpa C. microcarpa C. parviflora s.str. C. pilosa (Norfolk Island) C. propinqua C. repens C. rhamnoides C. rigida C. robusta C. rotundifolia C. rubra C. rugosa C. tenuicaulis C. virescens C. wallii C. sp. aff. parviflora (C. sp."t" of Eagle 1982) C. propinqua x C. robusta	AK 222519 AK 223925 CANU 36908 AK 223932 AK 222392 CHR 286201 AK 221871 AK 222214 AK 230988 AK 219433 AK 223922 CANU 36911 AK 222455 CANU 36588 AKU 14554 AK 222391 AK 222056 AK 223803 AK 228729 CHR 129804 AK 223951 AK 230698 AK 223931 AK 223801			
	Rutaceae	*Citrus Melicope	*C. limon M. simplex	CHR 219687 WAIK 14133			
	Salicaceae	*Populus *Salix	*P. alba *P. nigra *S. alba	AK 224935 AK 230997 CHR 286170			

			*S. babylonica *S. cinerea *S. fragilis *S. matsudana cv. “tortuosa” *S. xreichardtii *S. ?xsepulcralis *S. sp.	AK 224909 AK 212399 AK 222057 AK 223928 AK 223924 AK 226096 AK 230986			
	Sapindaceae	*Dodonaea*	*D. viscosa*	CHR 286147			
	Taxaceae	**Taxus*	**T. baccata*	AK 222454			
	Taxodiaceae	**Metasequoia*	**M. glyptostroboides*	AK 224111			
	Tiliaceae	**Tilia*	**T. xeuropaea*	AK 226100			
	Theaceaceae	**Camellia*	*C. japonica*	AK 228831			
	Ulmaceae	**Ulmus*	**U. procera* cv. “Louis Van Houtte” **U.* sp.	AK 224908 AK 225888			
	Violaceae	*Melicytus*	*M. crassifolius M. flexuosus M. lanceolatus M. micranthus M. obovatus* s. str. *M. ramiflorus* subsp. *oblongifolius* (Norfolk Island) *M. ramiflorus* subsp. *ramiflorus* *M.* sp. aff. *alpinus* (*M.*“ Blondin”) *M.* sp. aff. *alpinus* (*M.* “Brockie”) *M. micranthus* x *M. ramiflorus* subsp. *ramiflorus*	CHR 212999 AK 221711 AK 222028 AK 223952 AK 230990 AK 222384 AK 222037 AK 221711 AK 223936		CHR 224194	
	Winteraceae	*Pseudowintera*	*P. colorata*	CHR 286161			
Totals	**51**	**101**	**209**	**196**	**7**	**4**	**2**
	Indigenous Exotic Norfolk Island	44 57[§] 0[δ]	114 92 3	105 90 1	6 5 0	2 0 2	1 1 0

† *Rubus* is the only genus thus far parasitised which includes both indigenous and adventive taxa.
[§]Generic figure excludes *Rubus* which is here included under indigenous through convenience as only one of the five records is an exotic species.
δThree Norfolk Island genera parasitised by *Ileostylus* are indigenous also to New Zealand (*Coprosma*, *Melicytus* and *Pittosporum*). These taxa have been noted as such under the host species column. However for convenience they have been included in the indigenous subtotal given in this column.

TABLE 3. HOSTS OF *Peraxilla colensoi.*

MISTLETOE SPECIES	HOST FAMILY	HOST GENUS	HOST SPECIES	RECORD CATEGORIES			
				1	2	3	4
Peraxilla colensoi							
	Betulaceae	**Alnus*	**A. glutinosa*				Allan (1943)
	Fabaceae	**Robinia*	**R. pseudacacia*				Cheeseman (1925)
	Fagaceae	*Nothofagus* **Quercus*	*N. fusca* *N. menziesii* *N. solandri* **Q. robur* **Q.* sp.	 CHR 286130 WELTU 14822	 N. Baigent (pers. comm. 1994)	CHR 200577 CHR 288052	
	Myrsinaceae	*Myrsine*	*M. australis*				Richards (1956)
	Myrtaceae	*Metrosideros*	*M. excelsa* *M.* sp.			K (Colenso) CHR 22471	
	Pittosporaceae	*Pittosporum*	*P.* sp.				Allan (1961)
	Rosaceae	**Crataegus* **Malus* **Prunus* **Pyrus* **Rosa*	**C. monogyna* **M.* x*domestica* **P.* x*domestica* **P. communis* **R.* sp.	AK 226753		WELT 78308	 Cheeseman (1925) Cheeseman (1925) Allan (1961)
Totals	**7**	**12**	**16**	**3**	**1**	**5**	**7**
	Indigenous Exotic	4 8	7 9	2 1	0 1	3 2	4 3

TABLE 4. HOSTS OF *Peraxilla tetrapetala*.

MISTLETOE SPECIES	HOST FAMILY	HOST GENUS	HOST SPECIES	RECORD CATEGORIES			
				1	2	3	4
Peraxilla tetrapetala							
	Betulaceae	**Betula*	**B. pendula*	CHR 286200			
	Cunoniaceae	*Weinmannia*	*W. silvicola*	AK 212173			
	Elaeocarpaceae	*Aristotelia*	*A. fruticosa*	CHR 286134			
	Epacridaceae	*Dracophyllum*	*D. acerosum* *D. longifolium*	CANU 30588 CANU 36604			
	Escalloniaceae	*Quintinia*	*Q. serrata*	AKU 23308			
	Fagaceae	*Nothofagus*	*N. fusca* *N. menziesii* *N. solandri* var. *cliffortioides* *N. solandri* var. *solandri* *N. truncata*	AK 212090 AK 221704 CANU 36605		WELT 78571 CANU 35171	
	Loranthaceae	*Peraxilla*	*P. colensoi*	AK 221706			
	Myrtaceae	*Metrosideros*	*M. excelsa*			K (Cunningham)	
	Rosaceae	**Prunus*	**P. xdomestica*	CHR 499327			
	Rubiaceae	*Coprosma*	*C. propinqua* *C. rugosa*	AK 224905 CHR 125581			
	Verbenaceae	*Vitex*	*V. lucens*			K (Cunningham)	
Totals	**11**	**11**	**17**	**13**	**0**	**4**	**0**
	Indigenous Exotic	8 3	15 2	11 2	0 2	4 0	0 0

TABLE 5. HOSTS OF *Muellerina celastroides*.

MISTLETOE SPECIES	HOST FAMILY	HOST GENUS	HOST SPECIES	RECORD CATEGORIES			
				1	2	3	4
Muellerina celastroides							
	Myrtaceae	*Metrosideros*	*M.* ?sp.			P (Raoul)	
Totals	**1**	**1**	**1**			**1**	
	Indigenous	1	1	0	0	1	
	Exotic	0	0	0	0	0	0

TABLE 6. HOSTS OF *Trilepidea adamsii*.

MISTLETOE SPECIES	HOST FAMILY	HOST GENUS	HOST SPECIES	RECORD CATEGORIES			
				1	2	3	4
Trilepidea adamsii							
	Myrsinaceae	*Myrsine*	*M. australis*			WELT 7974	
	Rubiaceae	*Coprosma*	*C. arborea* *C.* sp	AK 103908			Cheeseman (1881)
	Rutaceae	*Melicope*	*M. ternata*				Cheeseman (1881)
Totals	**3**	**3**	**4**	**1**	**0**	**1**	**2**
	Indigenous Exotic	3 0	3 0	1 0	0 0	1 0	2 0

TABLE 7. HOSTS OF *Tupeia antarctica*.

MISTLETOE SPECIES	HOST FAMILY	HOST GENUS	HOST SPECIES	RECORD CATEGORIES			
				1	2	3	4
Tupeia antarctica							
	Araliaceae	**Hedera* *Pseudopanax*	**H. helix* *P. arboreus* *P. crassifolius* *P. edgerleyi*	CHR 123643 CANU 36940 AK 222544			Smart (1952)
	Asteraceae	*Olearia*	*O. fragrantissima* *O. paniculata* *O. traversii*	 CHR 416163 WELT 31337	B.D. Rance (pers. comm. 1995)		
	Elaeocarpaceae	*Aristotelia* *Elaeocarpus*	*A. serrata* *E. dentatus*	AK 222396 AK 222397			
	Escalloniaceae	*Carpodetus*	*C. serratus*	CHR 286164			
	Euphorbiaceae	**Ricinus*	**R. communis*		P. Cashmore (pers. comm. 1997)		
	Fabaceae	**Acacia* *Carmichaelia* **Chamaecytisus* *Chordospartium* **Cytisus* **Lupinus* **Robinia* **Virgilia*	**A. dealbata* *C. petriei* **C. palmensis* *C. stevensonii* **C. multiflorus* **C. scoparius* *L. arboreus* **R. pseudacacia* **V. divaricata* x *V. oroboides*	AK 223941 CHR 286165 CHR 286138 AK 230995 AK 230993 CHR 499342 AK 224934		 CHR 321051 CHR 140975	
	Fagaceae	*Nothofagus*	*N.* sp.			CHR 157512	
	Icacinaceae	*Pennantia*	*P. corymbosa*			CHR 97959	
	Loranthaceae	*Ileostylus* *Peraxilla*	*I. micranthus* *P. tetrapetala*	CHR 33398 AK 3861			
	Malvaceae	*Hoheria* *Plagianthus*	*H. angustifolia* *H. lyallii* *P. regius*	AK 221738 CHR 28226 AK 221740			

	Meliaceae	*Dysoxylum*	*D. spectabile*			CHR 405107	
	Myoporaceae	*Myoporum*	*M. laetum*	AK 230996			
	Myrsinaceae	*Myrsine*	*M. australis* *M. divaricata* *M. australis* x *M. divaricata*	AK 222822 AK 221709	P.J. de Lange (pers. obs.)		
	Oleaceae	*Nestegis*	*N. apetala* *N. cunninghamii*	AK 230700		AK 169522	
	Pittosporaceae	*Pittosporum*	*P. crassifolium* *P. eugenioides* *P. tenuifolium*	AK 222545 CHR 286167 AK 226754			
	Podocarpaceae	*Prumnopitys*	*P. taxifolia*			MPN 4990	
	Proteaceae	**Embothrium*	**E. coccineum*		P.J. de Lange (pers. obs.)		
	Rosaceae	**Crataegus* *Rubus*	**C. monogyna* *R. schmidelioides*	AK 226096 AK 231004			
	Ripogoniaceae	*Ripogonum*	*R. scandens*				Smart (1952)
	Rubiaceae	*Coprosma*	*C. crassifolia* *C. chathamica* *C. linariifolia* *C. propinqua* *C. parviflora* agg. *C. pseudocuneata* s.s	AK 223942 AK 221710 CHR 323025 CANU 7753		CHR 45964	Thomson (1949)
Totals	**20**	**32**	**48**	**33**	**4**	**8**	**3**
	Indigenous Exotic	22 10	37 11	25 8	2 2	7 1	3 0

Host specificity and spatial distribution patterns of mistletoes

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SUMMARY

Differences in host specificity amongst New Zealand loranthaceous mistletoes appear to reflect differences in the time they have been present in New Zealand, with the "old" mistletoes showing the highest degree of host specificity. In south Westland, forest type exerts a strong influence on mistletoe distribution, with *Peraxilla colensoi* more common in structurally diverse *Nothofagus menziesii* forests than in other forest types. In *Nothofagus solandri* forests at Craigieburn, *Alepis flavida* and *Peraxilla tetrapetala* appear to have a non-random distribution pattern within the forest, and also occur in the same host tree in different positions (*Peraxilla* on trunks and *Alepis* on outer branches). It is suggested that the main influences on mistletoe distribution in *Nothofagus* forests relate to both light levels and bird activity.

1. INTRODUCTION

Loranthaceous mistletoes are predominantly arboreal xylem parasites (Calder 1983), dependent on their host for water, nutrients and to some extent carbon (Reid *et al*. 1995, Norton & Reid, in press.). Mistletoes show wide variation in the degree of specificity in the host species they parasitise, with some species specialising on one or a few host species while others exhibit very little specificity (Norton & Reid, in press.). Mistletoes also exhibit non-random distribution patterns within the ecosystems they occur (e.g., Reid & Lange 1988, Norton *et al*. 1995), reflecting both their dependence on birds for dispersal and their dependence on the host tree for nutrients, water and location in a suitable light environment (Norton & Reid, in press.). In this paper I briefly review the degree of specificity in New Zealand loranthaceous mistletoes and summarise the spatial distribution patterns of the beech mistletoes (*Alepis* and *Peraxilla*). The results presented here are preliminary and fuller accounts will be published subsequently.

Norton, D.A. Host specificity and spatial distribution patterns of mistletoes. Pp. 105–109 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

2. HOST SPECIFICITY

An interesting feature of the New Zealand loranthaceous mistletoes is the difference in host specificity between species, with the two *Peraxilla* species and *Alepis* having high host specificity (primarily on *Nothofagus*), while *Tupeia* and *Ileostylus* have low host specificity, parasitising a wide range of host species (Norton *et al*. 1995, de Lange *et al*. 1997). Based on a survey of >1400 herbarium records we have been able to quantify this pattern (Norton & de Lange, unpubl. data). *Alepis flavida* is the most host specific species, having been recorded from only nine indigenous host species with >80% of herbarium records from *Nothofagus solandri*. The two *Peraxilla* species (*P. colensoi* and *P. tetrapetala*) are similar, being recorded from 7 and 15 indigenous host species respectively. *P. colensoi* also has a similar level of specificity on its principal host (*Nothofagus menziesii*) to *Alepis flavida*, while *P. tetrapetala* has lower specificity, being recorded c. 60% of the time from its principal host (*Nothofagus solandri*).

In contrast, *Tupeia antarctica* and *Ileostylus micranthus* have been recorded from a far larger number of indigenous host species (37 and 114 respectively), and have very low host specificity (<30% of herbarium sheets come from the most common host species). The low host specificity of *Ileostylus* in particular is also evident in the number of exotic species it parasitises (92, de Lange *et al*. 1997). Although parasitising a far larger number of host species nationally, *Tupeia* and *Ileostylus* do show considerable regional host specificity; e.g., *Ileostylus* primarily parasitises *Podocarpus totara* in Northland, *Pseudopanax arboreus* in the Rotorua area and *Coprosma propinqua* on the west coast of South Island (Norton & de Lange, unpubl. data).

Norton & de Lange (unpubl. data) suggest that differences in the history of these taxa in New Zealand may contribute to these differences in host specificity. Pollen types similar to those of modern day beech mistletoes have been in New Zealand since the early Tertiary (c. 45 million years BP), while pollen types comparable to *Tupeia* and *Ileostylus* first appear in the fossil record near the end of the Tertiary (4 million years BP). The three "old" taxa (*Peraxilla* and *Alepis*) have a relatively high degree of host specificity, while the two "young" taxa (*Tupeia* and *Ileostylus*) have much lower host specificity.

During much of the Tertiary, New Zealand was low lying with strongly leached soils and a warm-temperate climate. The environment appears to have been relatively stable for several millions of years. *Nothofagus* species were dominant, and over several millions of years the three beech mistletoe species appear to have developed a strong specialisation on members of this genus.

In contrast, *Tupeia* and then *Ileostylus* appeared at the end of the Tertiary, a time of rapid mountain building (Kaikoura Orogeny) and cooling climates, which was followed by the dramatic climatic fluctuations of the Pleistocene. While it would seem likely that evolutionary processes would favour the development of host specialisation, the major environmental changes that occurred during this time appear to have prevented this occurring (Norton & de Lange, unpubl. data). The dramatic fluctuations in plant distribution patterns between glacial and interglacial periods in particular would have provided a major barrier to the development of host specificity.

A tendency towards host specialisation is still apparent in *Ileostylus* and *Tupeia*, as evidenced by the presence of local host specificity despite the presence of other potential host species. It may be that if climates were to remain stable for long enough, then host specialisation would eventually occur (Norton & de Lange, unpubl. data).

3. DISTRIBUTION PATTERNS WITHIN A CATCHMENT

Loranthaceous mistletoes commonly have non-random distribution patterns, with high numbers of mistletoes in some areas and few or no mistletoes in others. While this pattern is quite apparent in the field, there have been few attempts to quantify it (but see Norton *et al*. 1995). In order to assess the distribution patterns of *Peraxilla colensoi* in *Nothofagus menziesii* forests in south Westland, we surveyed mistletoe abundance in the Thomas River catchment, an area largely free of possums (Owen 1994, Owen & Norton, unpubl. data). Our aim was to describe the spatial distribution of mistletoes within a *Nothofagus menziesii* forest, looking particularly at the influence of altitude and aspect, and forest type on mistletoe abundance.

We found *Peraxilla colensoi* to be significantly more common in mid-elevation plots than in lower or higher elevation plots (altitudinal range 150–1000 m), and it was not found above 680 m. At higher altitudes *P. colensoi* was replaced by *P. tetrapetala*. There was no significant difference in *P. colensoi* abundance with aspect, while *P. colensoi* was more abundance on faces (2.6 $\pm$ 3.3 *P. colensoi* plants per plot) than on ridges (0.8 $\pm$ 1.2) or terraces (0.7 $\pm$ 1.2).

Peraxilla colensoi was non-randomly distributed amongst potential host tree sizes. Large *Nothofagus menziesii* trees were parasitised significantly more often than expected compared to the numerically more abundant smaller diameter trees.

Three forest types were present in the study area, with *Peraxilla colensoi* densities significantly higher in mature *Nothofagus menziesii* forest (36 plants ha^{-1}) than in simple *N. menziesii* forest or mixed *Nothofagus-Weinmannia-Metrosideros* forest (6 and 8 plants ha^{-1} respectively). *P. colensoi* were present on *N. menziesii* trees of all sizes in the mature *N. menziesii* forest, but were confined to larger diameter trees only in the other forest types. *P. colensoi* was not evenly distributed through the forest profile, with most individuals present in the upper canopy.

The following conclusions can be drawn from this research (Owen & Norton, unpubl. data):

1. *Peraxilla colensoi* appears to be replaced by *P. tetrapetala* at higher altitudes, but there appears to be no significant difference in mistletoe abundance with aspect.
2. *Peraxilla colensoi* occurs more commonly in larger trees than in smaller trees, a result that has been found in many other studies. The two main reasons given for this are that large trees contain proportionally more of the total surface area available for mistletoe colonisation and hence should be expected to contain the majority of mistletoes, and because large trees are older, and other factors being equal, there will have been a greater chance of infestation by mistletoes. A further factor is that large trees may provide better habitat for mistletoes than smaller trees (e.g., in terms of light levels and bird perch sites).
3. Mistletoes occur more often in some forest types than in others. In this study we found a predominance of mistletoes in mature silver beech forests. These forests are characterised by a complex canopy structure with large often emergent *Nothofagus menziesii* trees over a lower canopy of silver beech and kamahi. *N. menziesii*

canopies are wide spreading and there are many gaps between the individual canopies. In contrast, simple *N. menziesii* forest is characterised by a dense canopy of *N. menziesii* with a relatively even canopy profile.

Other studies have suggested that mistletoes have a high light requirement (Norton & Reid, in press.) and mistletoes are commonly found in the upper parts of host trees, in open forest or at forest edges, and this also appears to be the case in New Zealand. Owen & Norton (unpubl. data) interpret their results as suggesting that mistletoes are most common in the mature *Nothofagus menziesii* forest type because of the higher light levels which provides a better environment for mistletoe establishment and growth. They also suggest that this structurally and compositionally diverse forest canopy may also provide better habitat for the bird species that disperse mistletoe seed.

4. DISTRIBUTION PATTERNS WITHIN A FOREST STAND

Mistletoes are also non-randomly distributed within a single forest type. For example, two 1 ha plots established within *Nothofagus solandri* forest at Craigieburn show mistletoes as having a clumped distribution (Norton, unpubl. data). In the same forest, Powell & Norton (1994) found that *Alepis flavida* and *Peraxilla tetrapetala* utilised the *Nothofagus solandri* canopy in different ways. *A. flavida* was primarily confined to the outer branches while *P. tetrapetala* occurred mainly on the main trunks. Both started growth on the outer branches, where birds deposited seeds, but in the case of *Peraxilla*, the plant grows down to the main trunk and it is only when it reaches here that it develops into its typical large clump form. In contrast, *Alepis* stays in the outer branches and as a consequence never becomes as large as *Peraxilla*.

5. CONCLUSIONS

Birds have a strong influence on mistletoe distribution because dispersal of mistletoe fruit usually occurs over short distances resulting in a greater probability that new mistletoe plants will be close to the parent plant rather than distant from it (Reid 1997). However, the data reviewed here suggests that differences in light environments may also be an important determinant of mistletoe distribution patterns in south Westland silver beech forests, a pattern that appears to be common for most beech mistletoes (B.P.J. Molloy, pers. comm.). These data support the suggestions of Norton & Reid (in press) who argue that non-random mistletoe distributions reflect both their dependence on birds for dispersal and on the host tree for nutrients, water and location in a suitable light environment.

6. ACKNOWLEDGEMENTS

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Reproductive ecology of the loranthaceous mistletoes of New Zealand

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SUMMARY

The three hermaphroditic loranthaceous mistletoe species — *Alepis flavida*, *Peraxilla colensoi* and *P. tetrapetala* — were found to be self-compatible, and bird pollinated. Both *Peraxilla* species display a type of the explosive bud opening mechanism not previously reported for any of the New Zealand loranthaceous genera. Dispersal for all five species was found to be bird mediated. If the fruit was not dispersed, germination did not occur. Loss of dispersing birds is suggested as a major factor in the decline of loranthaceae mistletoes in New Zealand.

1. INTRODUCTION

Prior to the 1990s, published material (and indeed knowledge) of the reproductive ecology of New Zealand's loranthaceous mistletoes was very limited. However, in recent years there have been several studies into the reproductive ecology (pollination, dispersal, germination and establishment) of New Zealands extant mistletoes (*Alepis flavida*, *Ileostylus micranthus*, *Peraxilla colensoi*, *P. tetrapetala* and *Tupeia antarctica*).

Published work prior to the 1990s on the New Zealand mistletoes consists of descriptions of the life history of *T. antarctica* (Smart 1952), aspects of the life history of *I. micranthus* (Menzies 1947), morphology and embryology of *P. tetrapetala* (Prakash 1960) and inflorescence morphology of several indigenous loranthaceous mistletoes (Kuijt 1981). There are also a number of publications listing mistletoe presence in an area and publications listing the species of host plant.

This article summarises the results of a Masters of Science thesis on the reproductive ecology of the five extant New Zealand Loranthaceous mistletoes (Ladley 1994). This research was carried out at three main study sites (Nelson, Craigieburn and Wainui) in the South Island.

Ladley, J.J. Reproductive ecology of the loranthaceous mistletoes of New Zealand. Pp. 111–114 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

2. POLLINATION

New Zealand's Loranthaceous mistletoes can be separated into two groups according to their pollination regimes. The first group consists of *I. micranthus* and *T. antarctica*, which are characterised as having minute yellow-green flowers which are presumed to be insect pollinated. *I. micranthus* is subdioecious (populations contain plants that have male, female or hermaphroditic flowers) and *T. antarctica* is dioecious (plants have either male or female flowers). The second group contains *A. flavida, P. colensoi* and *P. tetrapetala*. Plants of these three species are hermaphroditic, their flowers are brightly coloured and bird pollinated. The majority of my pollination work was carried out on the second group of species.

A major finding of the study was that the flower buds of both *Peraxilla* species are explosively opened (Ladley & Kelly 1995a). This process had been described for some overseas mistletoe species but it had never been described for an Australasian mistletoe before. Tui (*Prosthemadera novaeseelandiae*) and bellbirds (*Anthornis melanura*) were observed opening the buds. The bird grasps the top of the mature flower bud in its beak and twists its head causing the four petals of the bud to spring apart, revealing the large quantity of nectar which is pooled at the base of the petals (Ladley & Kelly 1995b). The whole process, from the bird grasping the bud through to it having taken the nectar, takes under a second.

If the flower bud is left unopened, the petals start to separate at the base of the bud. Eventually the bud will fall off the plant with the petals still fused at their apex (known as bottom opened).

Pollination experiments revealed that the three bird pollinated species were all self compatible (flowers were able to set fruit with their own pollen). Thus a proportion of the bottom opened buds of the *Peraxilla* set fruit.

Observations revealed that the quantity of flowers produced on a plant varies from year to year. There appears to be a bi-annual cycle of good flowering one summer and high vegetative growth the following summer. This is especially noticeable on *P. colensoi* plants, where the majority of the flowers are produced on stems which are one year old.

3. DISPERSAL

The flowers of all five loranthaceous mistletoe species develop into fruits containing a single seed. It was found that the fleshy fruits for all five species are bird dispersed. All the species of birds (tui, bellbird and silvereyes (*Zosterops lateralis*)) observed eating mistletoe fruits treated them in the same manner. The fruit was swallowed whole and defecated out. The seeds have a sticky viscin layer which enables them to adhere to a surface (such as a branch) after passing through the bird.

The behaviour of the disperser has the potential to affect the chance of the mistletoe seed reaching a safe establishment site (Ladley & Kelly 1996). For example, interactions between different bird species often affected the length of time a bird foraged in the mistletoe plant; tuis were seen to dominate the food source and chase away any bellbirds.

4. GERMINATION AND ESTABLISHMENT

Germination can occur on any surface. The rate of germination and establishment of the New Zealand mistletoes is slow, particularly when compared to the germination and establishment rates of tropical mistletoes. For example, after two years of growth an *A. flavida* seedling consisted of a main stalk and 8 very small leaves, whereas plants of the tropical mistletoe *Tapinanthus bangwensis* have been recorded flowering 10 weeks after germination (Room 1973).

Experiments revealed that all that was required for successful germination of a mistletoe seed was the removal of the fruit skin (Ladley & Kelly 1996). This was usually achieved by the passage of the fruit through a bird's gut.

It was found that the free living stage of the mistletoe's life cycle (between germination and establishment) had a very high mortality rate. For example, only 15% of the *P. colensoi* seeds that germinated were still alive 12 months later (Ladley & Kelly 1996).

5. IMPLICATIONS FOR MISTLETOE CONSERVATION

There is potential for mistletoe species to be used as indicators of change in forest ecosystems, due to the high level of dependency that they have on their frugivorous dispersers and their need for suitable host species. It may be that present mistletoe densities reflect a combination of factors including the effect of forest fragmentation, the potential effect of possum browse and alteration of bird densities in the area (Ladley & Kelly 1995a).

This study into the reproductive ecology of the New Zealand loranthaceous mistletoes has shown that conservation of these species is closely related to the conservation of potential host plants (providing successful establishment sites) and the conservation of the bird species that act as mistletoe pollinators and dispersers. It is the potential loss or decline in numbers of the bird species important for pollination and dispersal of the mistletoes that is probably the greatest threat to the continuation of a healthy, self sustaining, mistletoe population within a particular area.

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Some aspects of reproduction and possum control of five loranthaceous mistletoes in the central North Island and comparisons with South Island studies

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SUMMARY

Five loranthoid species of mistletoe are being studied in the Central Volcanic Plateau, North Island, New Zealand. Information on pollinator and seed dispersal vectors, reproduction rates and the effect of browse on these rates is required for the conservation management of these threatened indigenous species. Research to date indicates that native bird species are heavily involved with pollination and seed dispersal. Browse, particularly by the Australian brush-tailed possum (*Trichosurus vulpecula*), is appearing to have an inhibitory effect on the reproduction of these central North Island species. Comparisons between the same species in the North and South Islands is yielding some interesting discrepancies, especially in relation to the browse studies.

1. INTRODUCTION

Mistletoes have become a national focus for concern in recent years due to an apparent decline in populations that were formally widespread. Research on their biology, ecology, and conservation is being conducted as a national programme, involving various government and private organisations.

In the late 1980s, the Tongariro/Taupo Conservancy of the Department of Conservation became concerned that their highly visible mistletoes were no longer obvious. In 1989, an initial survey was carried out, visiting sites that historically had mistletoes. A few plants were found but these were in poor condition.

Information on the reproductive ecology and modes of pollination and dispersal in the North Island mistletoe populations is lagging behind that of the South Island populations. This information is needed to implement effective

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conservation management strategies for the species. My work began in 1991 and involved surveying areas of Tongariro National Park to locate mistletoes and record their health. My current work which forms part of a Masters degree is an extrapolation of these earlier surveys.

At the turn of the century, all loranthaceous mistletoes occurred widely throughout New Zealand, at least in beech forest (Ogle and Wilson, 1985). The initial hypothesis for the mistletoes' decline in the Tongariro National Park area was that it was due to possum (*Trichosurus vulpecula*) browse. However, the causes appear more complex. Nationwide, there are now three main factors which in combination appear largely responsible for the decline of these populations:

- the browsing of the Australian brush-tailed possum,
- the destruction of the mistletoes' habitats,
- a decrease in numbers of their pollinating and seed-dispersing vectors.

2. STUDY AREAS

I am studying five of the loranthaceous species that occur in and around the Tongariro National Park. The study areas are:

1. ***Alepis flavida*** – Round the Mountain Track, Tongariro National Park (eastern side of the Ohakune Mountain Road). This area is at 1300m altitude and contains isolated patches of krummholz mountain beech (*Nothofagus solandri* var. *cliffortioides*) which is the host for *A. flavida*. The mountain beech is the dominant tree species and forms a canopy up to 3m high. Other tree species present are *Halocarpus biformis* and *Phyllocladus alpinus*. The understorey is an alpine tussock-shrubland/wetland community with *Chionochloa rubra*, *Dracophyllum recurvum* and *Podocarpus nivalis*, various *Juncus* species, and many herbaceous plants present.

2. ***Peraxilla colensoi*** – Rangataua State Forest, Ohakune. This area is at about 700m altitude and is surrounded by exotic *Pinus contorta* plantations. In the native forest remnant, red beech and silver beech (*Nothofagus fusca* and *N. menziesii*) form a canopy 20m high. Both these species act as hosts for the mistletoe. Sub-canopy species include *Pseudopanax crassifolius, Carpodetus serratus* and various *Coprosma* species. The understorey comprises various fern species such as *Blechnum discolor*, *B. vulcanicum*, *B. chambersii*, and *Hymenophyllum sanguinolentum*.

3. ***P. tetrapetala*** – Mangawhero Falls, Ohakune Mountain Road (eastern side), Ohakune.This area is at 1275m altitude with stands dominated by mountain beech (the host for the mistletoe) forming a canopy of 4m and including *Phyllocladus alpinus* as a sub-dominant. The tussockland/herbfield understorey contains *Podocarpus nivalis* and *Hebe venustula* and is dominated by herbaceous alpine species, namely *Celmisia spectabilis*, *C. incana*, and *Rytidosperma setifolia*.

4. ***Tupeia antarctica*** – Omori Scenic Reserve, Lake Taupo. This area is different from the previous study areas in that it is a highly modified environment. It is at 550m altitude and is a fairly open area with plantings of stands of *Pittosporum tenuifolium* trees, most as isolated individuals. *P. tenuifolium* is the mistletoe host. In the forested surrounds, the canopy is 12m high and dominated by *Pseudopanax arboreus and Pittosporum tenuifolium*. Sub-canopy includes *Hebe stricta* and *Leucopogon fasciculatus*.

5. ***Ileostylus micranthus*** – Braxmere Lodge, Waihi, Lake Taupo. This area is also modified being in the grounds of a fishing lodge. There are isolated trees of *Malus* sp., *Citrus limon*, *Pyrus communis*, *Metrosideros* sp., *Pittosporum tenuifolium* and *Magnolia* sp. There are five different host species here: *Malus* sp. (crab apple), *Kunzea ericoides* (kanuka), *Pittosporum tenuifolium* (kohuhu), *Metasequoia glyptostrobioides* (Dawn Redwood) and *Pseudopanax arboreus* (five finger).
6. Western side, Ohakune Mountain Road. This area is comparable with *the P. tetrapetala* site, the only difference being that no possum control work has been carried out in this area by the Derartment of Conservatiuon.

The species and their particular hosts are indicated in Table 1.

TABLE 1. MISTLETOE AND HOST SPECIES.

LORANTHACEOUS SPECIES	HOST SPECIES (IN STUDY AREAS)
Alepis flavida	Mountain Beech (*Nothofagus solandri* var. *cliffortioides*)
Peraxilla tetrapetala	Mountain Beech (*Nothofagus solandri* var. *cliffortioides*)
P. colensoi	Silver Beech (*Nothofagus menziesii*) Red Beech (*Nothofagus fusca*)
Ileostylus micranthus	Kanuka (*Kunzea ericoides*) Apple (*Malus* sp.) Kohuhu (*Pittosporum tenuifolium*) Dawn Redwood (*Metasequoia glyptostroboides*) Five-finger (*Pseudopanax arboreus*)
Tupeia antarctica	Kohuhu (*Pittosporum tenuifolium*) Tarata (*Pittosporum eugenioides*)

3. AIMS

To effectively manage mistletoes for conservation, information is required on their reproductive ecology and the effects of browsers, particularly possums, and dispersers. The following questions are being addressed during my study:

1. What are the present and likely past pollinators of *Alepis, Peraxilla, Tupeia* and *Ileostylus* species?
2. What is the timing and quantity of fruit development for the mistletoe species?
3. What are the present and likely past seed dispersers for the mistletoe species?
4. What effect do possums have on mistletoe reproductive processes?

The mistletoe species that are found in my study areas are more abundant in the South Island where they are a major nectar source (along with honey dew) for
native birds in the beech forests. Comparisons between the North and South Island populations are useful particularly as the processes of decline appear to be different. For example, possum predation of the mistletoes appears far less widespread in the South Island.

Studies of the North Island populations, however, are hampered by the small sample sizes associated with these threatened taxa. Consequently, the statistical analyses possible with larger populations cannot be conducted. This situation reflects problems associated with researching threatened species

4. METHODS

Addressing each of the above questions in turn:

1 & 3. Time Lapse video equipment (courtesy of the Forest Research Institute, Rotorua) is being used to record consecutive 24 hour periods. The camera is equipped with an infra-red light source which automatically comes on when darkness falls. The video can be set for periods of 3, 12, 48 etc hours. This, as well as field observations, are used to determine pollinating and dispersing vectors. A literature search was done for information on likely past important vector species (see Table 2).

TABLE 2. POLLINATING VECTORS.

MISTLETOE SPECIES	NORTH ISLAND	SOUTH ISLAND
Alepis flavida	tui (*Prosthemadera novaeseelandiae*)? bellbird (*Anthornis melanura*)? silvereye (*Zosterops lateralis*)? bats (*Mystacina tuberculata*)?	bellbird (*Anthornis melanura*)
Peraxilla colensoi	tui (*Prosthemadera novaeseelandiae*) bellbird (*Anthornis melanura*) bats (*Mystacina tuberculata*)?	tui (*Prosthemadera novaeseelandiae*) bellbird (*Anthornis melanura*)
P. tetrapetala	tui (*Prosthemadera novaeseelandiae*) bellbird (*Anthornis melanura*) silvereye (*Zosterops lateralis*) bats (*Mystacina tuberculata*)?	?
Ileostylus micranthus	insect spp.	honey-bees (*Apis* sp.)
Tupeia antarctica	insect spp. gecko (Gekkonidae)?	insect spp.
Species possibly important in the past	huia (*Heteralocha acutirostris*) stitchbird (*Notiomystis cincta*) saddleback (*Philesturnus carunculatus*) kokako (*Callaeas cinerea*)	?

Source for South Island data: Ladley, 1994.
? = not confirmed.

2. Some flowering mistletoes in the five study areas have had branches (*Alepis* = inflorescences) tagged so that the fate of flower buds can be followed through to fruit set and dispersal. All of the flowers are counted on small plants (see Table 3).

4. Information is regularly recorded (at least once a year since 1991) on the type of browse (possum/insect) suffered; the % foliage loss, the dimensions of the mistletoe clump, the health and reproductive state of the mistletoe and of the host plant with respect to all known mistletoe plants in the Park.

TABLE 3. SUMMARY OF PLANTS FOLLOWED.

SPECIES	NUMBER OF TAGGED PLANTS	NUMBER OF TOTAL COUNT PLANTS
Alepis flavida	2 (40 tags each)	6
Peraxilla colensoi	–*	2*
P. tetrapetala	3 (35 tags each)	3
Ileostylus micranthus	4 (35 tags each)	3
Tupeia antarctica	10 (50 tags each)	10

* Only two small plants produced flowers and fruit at this site.

5. PROGRESS TO DATE

There is still field work to be completed but I can present some tentative conclusions:

1. The *Peraxilla* and *Alepis* species have prolific, brightly coloured, floral displays. The *Peraxilla* species have what is termed "explosive" opening of the flowers (Ladley, 1994). All of these features suggest birds as pollinators. Indeed, in the case of the *Peraxilla* species, the explosive flowering suggests some co-evolution with bird species. These flowers will not open unless a bird twists the top of the mature flower bud, causing the petals to peel back and a cloud of pollen to disperse, covering the bird's head. Such features are known in overseas mistletoe species (Ali, 1931; Davidar, 1983; Feehan, 1985; Johri, 1987). Bats (*Mystacina tuberculata*) are another possible pollinator as these mistletoe species are copious nectar producers and bats are known to access other high nectar producing sources (e.g., *Dactylanthus taylorii, Phormium* species). However, *Ileostylus* and *Tupeia* have small, dull coloured flowers suggesting wind or insect pollination (Table 2).

In the 1993/94 season, after protection from possums, the *Peraxilla* mistletoes in the study areas began flowering, following several non-flowering years. However, these plants were not visited by pollinating vectors. Pollination was far more successful over the 1994/95 summer. The reason for this pattern is unclear. 1993/94 could possibly have been a good flowering season for many plant species. Thus, there was no need for the bird species to visit the mistletoes, as other food sources were more abundant and easily obtainable. Moreover, in the beech forests with open understoreys there are no other major flowering species present. Consequently, these areas would be of low attraction to bird species as energy gain would not be greater than energy expended.

Another possible explanation for the year-to-year variation is the feeding behaviour of the suspected pollinating vectors. For example, tui guard flowering trees and revisit these trees every year when they flower and fruit. Bellbirds (*Anthornis melanura*) have a limited foraging range but may visit all flowering trees within a particular area. Silvereyes (*Zosterops lateralis*) will defend a good food area (when in flocks). The bird species may have included the mistletoes in their foraging areas in 1994/95 once they were aware that the resource was once again available. There are signs also that bird numbers

are increasing after 1080 drops in 1993/94, so lack of pollination might have been limited by number. However, the fact that bird species are not visiting the flowers of mistletoes and hence pollinating them might not be as big a problem as first anticipated. Work by J. Ladley of Canterbury University shows that *Peraxilla* and *Alepis* species are self fertilising if not opened. Fruit set, while small, does occur (16%).

Another problem in the study areas is that the native bird species are being forced out by exotic bird species such as magpies (*Gymnorhina tibicen*), which do not seem interested in the mistletoes e.g., at the Omori Scenic Reserve.

Extinct avian species and those with a reduced present- day distribution could have been important as pollinators in the past (Table 2). There is also the possibility that with the general absence of mistletoes, birds have forgotten their worth as a nectar source. This hypothesis is difficult to test.

2. So far, fieldwork suggests the onset of flowering and fruiting in the North Island for all species is about one month behind plants in the South Island. Flowering (maybe also fruiting) periods in the North Island are slightly shorter than the South (Table 4).

TABLE 4. FLOWERING AND FRUITING TIMES FOR NORTH ISLAND LORANTHACEOUS MISTLETOES.

SPECIES	FLOWERING	FRUITING
Alepis flavida	Feb.	May – June
Peraxilla tetrapetala	Late Jan. – Feb.	June – July?
P. colensoi	Mid Jan. – Feb.	Apr. – July?
Ileostylus micranthus	Oct. – Dec./Jan.?	May – July?
Tupeia antarctica	Oct. – Nov.	July – October?

? = not confirmed

Initial work carried out on the *Peraxilla* species suggests that of the total flowers set, an average of 57% of *P. colensoi* flowers and 59% of *P. tetrapetala* flowers set fruit. These statistics can only be estimates as the sample size (especially for *P. colensoi* where n=2) is very low. Those that did not set fruit did so because (in order of significance):

– they were not pollinated
– they were subject to insect predation,
– flower buds were aborted (for whatever reason).

This phenology work is being carried out for the other three species (*Alepis flavida, Ileostylus micranthus, Tupeia antarctica*) and it still remains to be seen how much of the fruit (for all species):

– survives fruit maturation
– gets dispersed
– germinates and successfully establishes
– produces a subsequent generation.

3. Field observations have shown that ripe fruit of *Alepis flavida, Peraxilla colensoi* and *P. tetrapetala* that are not dispersed become overmature and start rotting while on the plant, or fall off and rot on the ground.

For all five mistletoe species, birds are the most likely dispersal vectors – the fruit is apparently highly nutritious (Johri and Bhatnager, 1972 in Godschalk, 1983). For *Tupeia*, geckos have been suggested as a potential vector (D.R. Towns, pers. comm.). Gecko lizards are possibly involved with dispersal of *Ileostylus* fruit as well, due to the proximity of the two study sites and the high probability of gecko species being present at both. In 1994, fruit of *Tupeia* was left maturing on the plants for the majority of the year and fruit was taken in a short time span in August/September. By contrast, in 1995, mature fruit made their first appearance in early June and birds have been feeding throughout. This yearly variation in fruit maturation and dispersal (in all mistletoe species) has important implications for conservation management.

The importance of bats as mistletoe dispersers has yet to be tested. Trialling bats in terms of mistletoe fruit preference will be carried out by Shirley McQueen and Brian Lloyd (Science and Research, Department of Conservation) as short-tailed bats (*Mystacina tuberculata*) occur in the Central Plateau area and may be dispersers.

Insectivorous tomtits (*Petroica macrocephala)* have been observed taking *Alepis flavida* fruit. This was seen on only two occasions and whether the absence of other bird species has led to this behaviour is unclear. Fieldwork has yet to be completed for all mistletoe species but bellbirds, silvereyes and tui have been seen feeding on *Tupeia* fruit; bellbirds and blackbirds (*Turdus merula*) have been recorded taking fruit from *Ileostylus*; and tui have been seen feeding on *Peraxilla colensoi.* All five species of mistletoe are bird dispersed in the South Island (Table 5).

4. The negative effect of possum browse on North Island mistletoe reproduction is illustrated by a variety of factors:

– Mistletoes flower on the previous year's woody growth. As possums preferentially target the new seasons vegetative growth, two seasons worth of flowering can be wiped out in one browse session. Stripped and damaged branches will die. Continuous browsing will eventually kill a mistletoe.

TABLE 5. SEED DISPERSAL VECTORS.

MISTLETOE SPECIES	NORTH ISLAND	SOUTH ISLAND
Alepis flavida	tomtit (*Petroica macrocephala*) kereru (*Hemiphaga novaeseelandiae*)? silvereye (*Zosterops lateralis*)? bellbird (*Anthornis melanura*)? tui (*Prosthemadera novaeseelandiae*)? exotic bird spp.? bats (*Mystacina tuberculata*)?	bellbird (*Anthornis melanura*) silvereye (*Zosterops lateralis*)
Peraxilla colensoi	tui (*Prosthemadera novaeseelandiae*) silvereye (*Zosterops lateralis*) kereru (*Hemiphaga novaeseelandiae*)? blackbird (*Turdus merula*)? bats (*Mystacina tuberculata*)?	tui (*Prosthemadera novaeseelandiae*) bellbird (*Anthornis melanura*)

P. tetrapetala	tui (*Prosthemadera novaeseelandiae*)? bellbird (*Anthornis melanura*)? silvereye (*Zosterops lateralis*)? kereru (*Hemiphaga novaeseelandiae*)? exotic bird spp.? bats (*Mystacina tuberculata*)?	?
Ileostylus micranthus	bellbird (*Anthornis melanura*) blackbird (*Turdus merula*) tui (*Prosthemadera novaeseelandiae*)? silvereye (*Zosterops lateralis*) gecko (Gekkonidae)?	tui (*Prosthemadera novaeseelandiae*) bellbird (*Anthornis melanura*) silvereye (*Zosterops lateralis*)
Tupeia antarctica	bellbird (*Anthornis melanura*) tui (*Prosthemadera novaeseelandiae*) silvereye (*Zosterops lateralis*)? gecko (Gekkonidae)?	bellbird (*Anthornis melanura*)
Species possibly important in the past	saddleback (*Philesturnus carunculatus*) kokako (*Callaeas cinerea*) huia (*Heteralocha acutirostris*) Kaka *Nestor meridionalis*) hihi (*Notiomystis cincta*) piopio (*Turnagra capensis*)	?

Source for South Island data: Ladley, 1994.
? = not confirmed.

– As many of the mistletoes in the National Park area had not flowered for several years (prior to protection) due to the assumed effects of possum browse, the pollinating and seed dispersing vectors were denied the nectar and fruit resources of the mistletoes. When flowering of protected mistletoes was re-established in the 1993/94 summer, in practically all cases of the *Peraxilla* species, the flowers were not visited and pollinated. The *Ileostylus, Alepis,* and *Tupeia* species have continued to set flower and fruit, which suggests that these species are less susceptible to possum browse, or the possums are targeting the *Peraxilla* species instead of other species in the area. Obviously more work is needed.

On the western side of the Ohakune Mountain Road no possum control work has been carried out. The *Peraxilla tetrapetala* at this uncontrolled site has possum browse ranging from 60 – 90% of the foliage. None of these mistletoe plants have managed to set fruit since monitoring began in 1993/94.

Studies in the South Island indicate that possum browse is less than in the North Island and thus these marsupials may not have such a significant negative effect on mistletoe reproduction. In fact, the major cause of foliage browse at some sites has been attributed to insect attack (Ladley, 1994). Significantly, the South Island populations appear relatively healthy compared to the North Island ones, although the populations in the former have been significantly reduced in both number of individuals and abundance. Insect browse does occur in the North Island populations, but the effect of this type of browse is eclipsed by that of the possums.

6. CONCLUSIONS

South Island studies indicate that that birds are more important for dispersal of seed than for pollination. There is evidence for this in the North Island too.

Flowering and fruit development of mistletoes in the central North Island is over a shorter period and about a month behind that of the South Island.

Possum browse has an inhibitory affect on mistletoe reproduction in the central North Island study areas, and could have serious effects on the survival of a population.

Continued (regular) monitoring is important in order to document year-to-year variation which could be significant with respect to conservation management.

If no further protection work is undertaken, New Zealand's endemic mistletoes may become even more restricted and perhaps extinct, at least in the North Island. The loss of the mistletoes will have an unknown effect on New Zealand's struggling native bird populations. We do not know what other ecological consequences will follow as a result of this loss of our indigenous flora.

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Mistletoe Moths

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SUMMARY

Foliaceous New Zealand mistletoes support a small fauna of specialist native moths and a few generalists. Leaf, flower and stem damage by the specialist species is a normal occurrence while leaf damage by the generalists may be spasmodic.

1. INTRODUCTION

The New Zealand mistletoes (family Loranthaceae) support a small fauna of native moths (Lepidoptera) in the families Geometridae and Yponomeutidae. As well, some polyphagous (generalist) moths in Tortricidae and Psychidae have been recorded from mistletoes.

Our mistletoes support a smaller, less diverse fauna than do Australian mistletoes, where mistletoe specialists include members of Lycaenidae (Common & Waterhouse 1972), Noctuidae, Saturniidae, Oecophoridae (Xyloryctinae) (Common 1990) and several leaf-mining groups (JSD, pers. obs.). A *Zelleria* species (Yponomeutidae) on mistletoes is reported from India (Zhang 1994).

Foliaceous mistletoes in New Zealand (*Ileostylus, Peraxilla, Tupeia*) support both specialists (species monophagous or feeding only on our Loranthaceae) and a few generalists. Apart from the record of *Declana griseata* Hudson (Geometridae) feeding on *Peraxilla* (as *Elythranthe*) *colensoi* (Hudson 1939) and the note that Loranthaceae support two genera of defoliators and one miner/flower eater (Dugdale 1975), there is no extensive treatment of the fauna associated with New Zealand mistletoes. The lectotype of the now presumed extinct *Trilepidea adamsii*, illustrated by Wright (1993), shows browsing damage closely resembling that of a browsing caterpillar.

2. METHODS

Both authors have extensive anecdotal records of mistletoe feeding by lepidoptera, particularly on *Ileostylus micranthus* in Woodhaugh Gardens, Dunedin, where it is abundant as a parasite on many shrubs and trees, but is

Patrick, B.H. and Dugdale, J.S. Mistletoe moths. Pp. 125–132 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

especially abundant on the shrub *Coprosma propinqua*. We have searched *Peraxilla colensoi* in many areas nation-wide, including the Waipori Valley near Dunedin, where it

is abundant on silver beech. Storm damage in the winter of 1995 brought down many branches and aided study of the insect damage. Larvae were reared and a collection of larval damage and adults are held in the private collection of BHP. Additionally, much material, including many specimens collected or reared by JSD, is in the New Zealand Arthropod Collection, Landcare Research NZ at Mt Albert, Auckland. The following moth species were found, with the specialist species being listed in Table 1.

TABLE 1. SPECIALIST LEPIDOPTERA ON *Ileostylus*, *Tupeia* AND *Peraxilla* WITH THEIR NEW ZEALAND DISTRIBUTION, TYPE LOCALITIES AND FEEDING SITE.

FAMILY AND SPECIES	NEW ZEALAND DISTRIBUTION (TYPE LOCALITY)	FEEDING SITE
Geometridae		
Ennominae		
Declana griseata Hudson	North and South Islands (Head of Lake Wakatipu)	Browsers of leaves of *Ileostylus*, *Tupeia* and *Peraxilla*, ? *Trilepidea*
Larentiinae		
Tatosoma agrionata (Walker)	North and South Islands (Hawkes Bay or Taupo)	Browsers of leaves of *Ileostylus*, *Tupeia* and *Peraxilla*, ? *Trilepidea*
Yponomeutidae		
Zelleria sphenota (Meyrick)	South Island (Riccarton Bush, Christchurch)	Miner, buds, stem, flowers, leaves, fruit, *Ileostylus* and *Peraxilla*
Zelleria maculata Philpott	South Island (Maungatua)	Miner, flowers, leaves *Peraxilla*

3. THE SPECIALIST MOTH SPECIES

3.1 Family Geometridae

***Declana griseata* Hudson, 1898.** (Figs 1, 2)

This stout-bodied geometrid species was reared by Hudson (1939) from larvae on *Peraxilla colensoi*. We have seen possible feeding damage on both *P. colensoi* and *P. tetrapetala*, but know it positively from *I. micranthus* and *Tupeia antarctica*. It is common on *I. micranthus*.

The adult moth is known from throughout both main islands from July to May and up to 988 metres altitude in forest localities. The adults are generally only moderately common, although six months of light-trapping at Deep Cove, Fiordland produced 187 adults, indicating that mistletoe is plentiful there.

There are probably two generations a year judging by both the speed of larval feeding and spread of adult emergence times. Two peaks of emergence have been identified: August–early November and again March until May.

The dark purplish-black larvae feed on the foliage of *I. micranthus* and grow to about 38 mm in length. The larva has a large wart-like process on the thorax, and a posterior dorsal wart and ridge on abdominal segment 8. The arboreal-feeding larvae pupate just below the soil surface or, if the situation allows, up to a metre above ground in a dry site such as on a log.

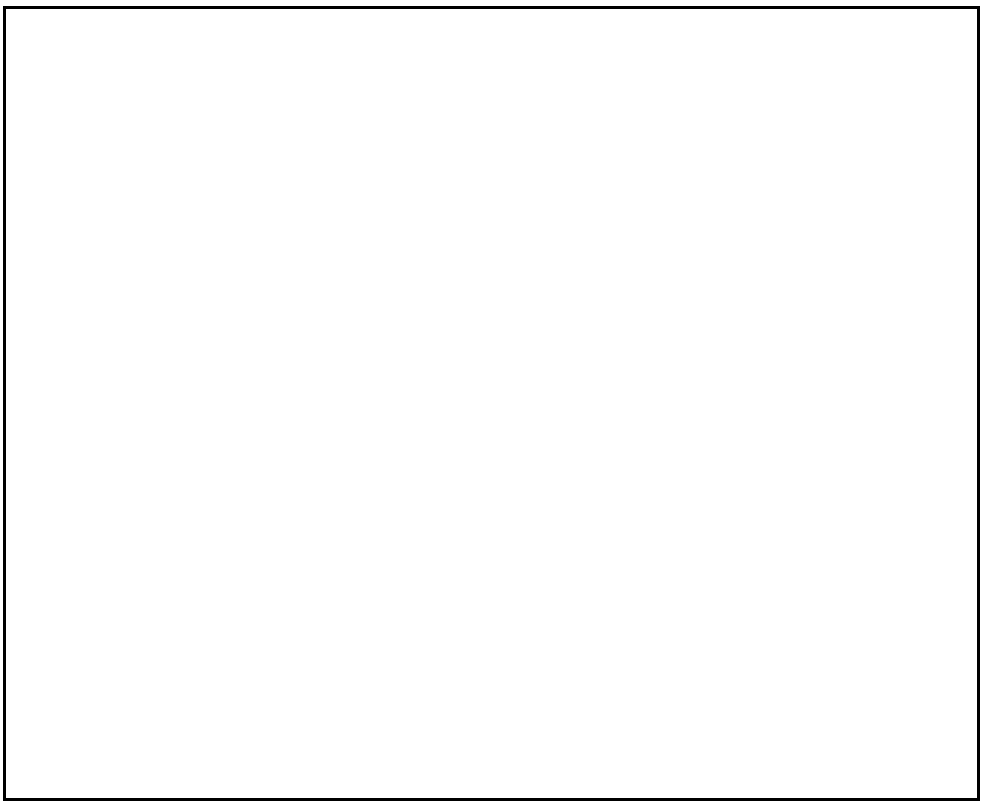

FIGURE 1. *Declana griseata* LARVA, ON MISTLETOE, WOODHAUGH, DUNEDIN, 23/4/76.

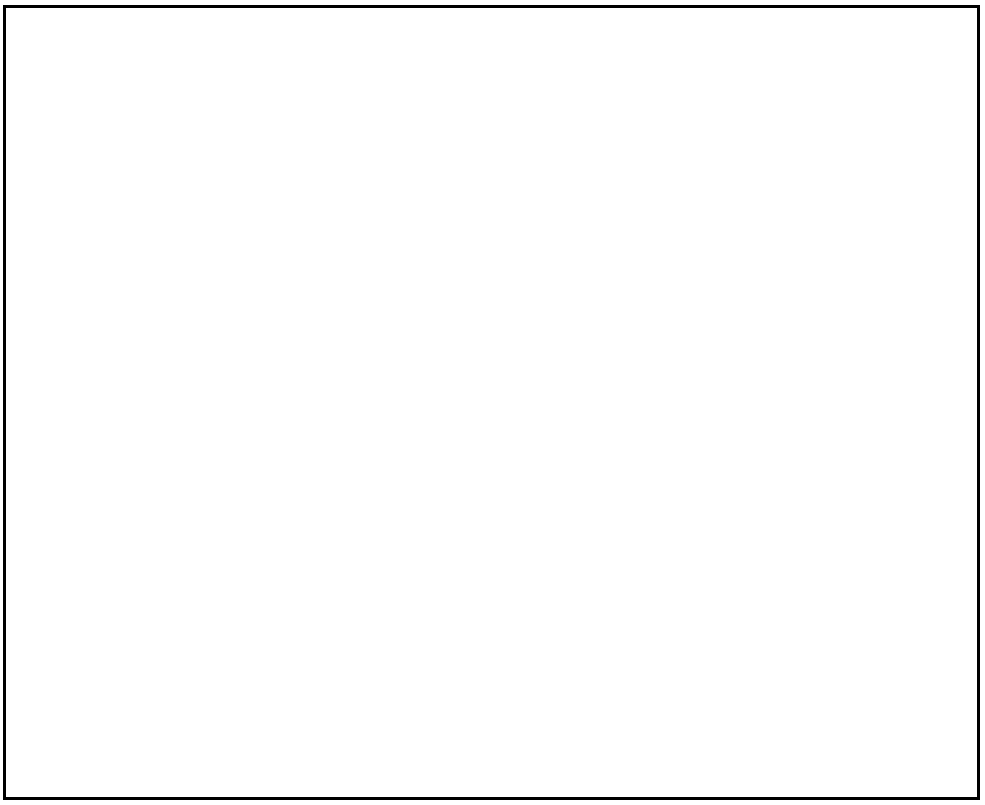

FIGURE 2. *Declana griseata* (FEMALE), 11/7/76, DUNEDIN.

***Tatosoma agrionata* (Walker 1862)** (Figs 3, 4)

The handsome moss green adult of *T. agrionata* has the distinctive long thin abdomen and modified male hindwings which sets this genus apart from other New Zealand geometrid genera. The species is, or was, moderately abundant throughout its range from the centre of the North Island (Rotorua, Ruapehu, Hawkes Bay) to Stewart Island. In our experience it is still reasonably abundant in the South Island but now rare in the North Island.

The adults emerge from July to May with probably two generations per year. Adults have been collected from forested areas up to 900 metres in altitude.

The attractive green larvae are very cryptic on the host leaf (*I. micranthus*). They are slow moving. Laterally they are a yellow-green, with few markings and are slightly paler ventrally. On hatching, the young larvae are orange but they feed quickly on the young *I. micranthus* foliage. A cocoon is formed of soil and silk at the ground surface.

The adults are very camouflaged on the mossy trunks of many tree species that grow in the vicinity of their larval host.

3.2 Family Yponomeutidae

***Zelleria sphenota* (Meyrick 1889)** (Fig. 5)

***Zelleria maculata* Philpott 1930**

The common "scribbles" on the leaves of *I. micranthus, P. colensoi* and *P. tetrapetala* are the abandoned leaf-mines of the larva of the yponomeutid moths *Zelleria sphenota* or *Z. maculata*. This species was described by Meyrick from Riccarton Bush, Christchurch and appears to be identical to a subsequently described species, *Z. rorida*, Philpott, from Bluff. Similar leaf-mines on *P. colensoi* and *P. tetrapetala* are caused by the larva of the longer-winged *Z. maculata* described by Philpott from Maungatua.

The leaf-mines are commonly found near the margins of the leaves, often linking one margin with another. Only rarely are the young larvae found in these "scribble mines" on the leaves of the host. They move from one mine after a few days to form a new mine on either the same leaf or a nearby leaf. At about fourth instar the larva ceases to be a leaf-miner and either moves up to the area of developing leaf-buds and mines the stem, eventually feeding within the new leaves, or becomes a leaf feeder, hiding within a silken gallery between overlapping leaves of mistletoe for 8–10 days. With *Z. maculata*, the larvae also eats out the reproductive parts of the flower, moving from flower to flower, particularly in large flowered *Peraxilla* spp.

The mature green larva (9 mm) then forms a spindle-shaped white silk cocoon covered by a loose silk second layer, usually on the mistletoe stem, in which it pupates. The pupal stage can be as short as 10 days. The species can be locally common with adults emerging from August until February. There is probably only one generation per year but with a protracted emergence period.

The adult moths are small, less than 15 mm wingspan with a very distinctive resting stance; head down tail up, at a sharp angle to the surface. The brown-grey wings have whitish marks and a traverse darker brown band. Adults have been found in forest up to 900 metres altitude. We have records of the two

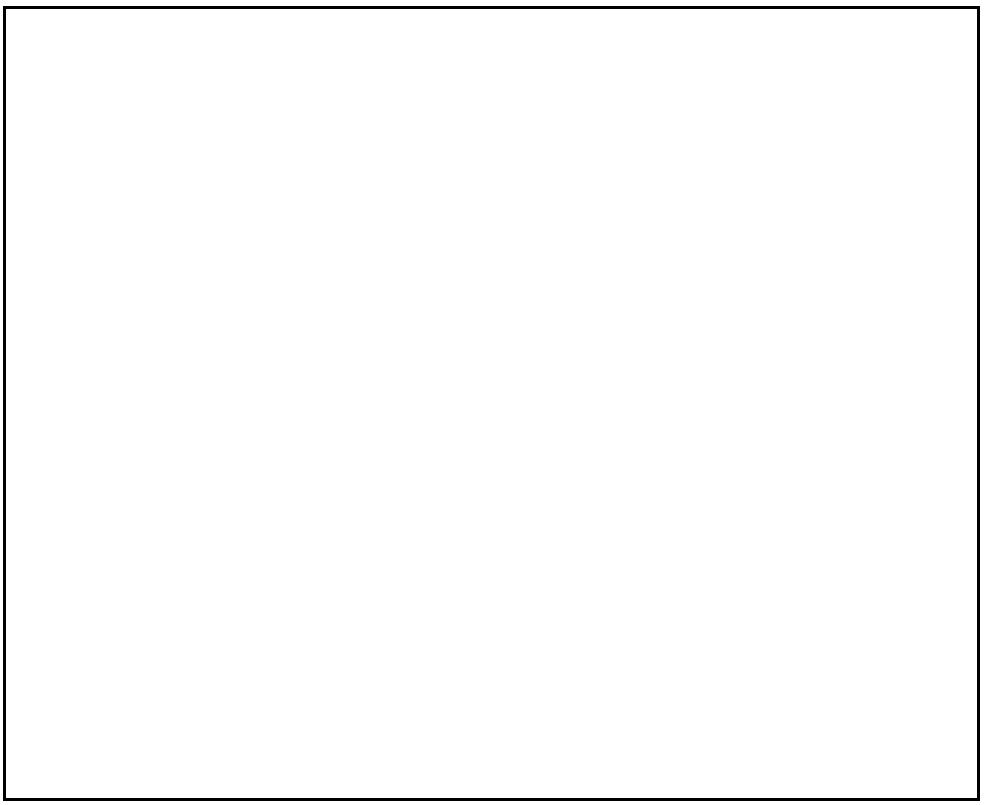

FIGURE 3. *Tatosoma agrionata* LARVA, ON *Ileostylus micranthus*, DUNEDIN, NOVEMBER 1982.

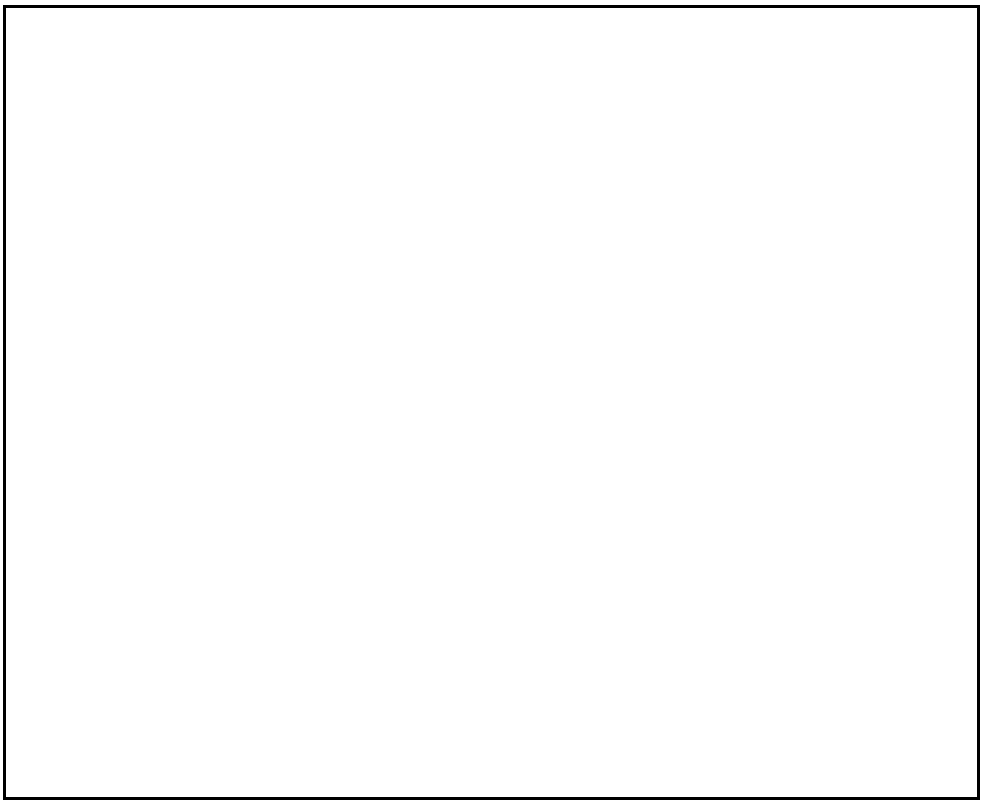

FIGURE 4. *Tatosoma agrionata* ADULT MALE, DUNEDIN TOWN BELT, 31/1/76.

species from Southland (including Fiordland), Canterbury, Nelson and the West Coast in the South Island.

4. THE GENERALIST MOTH SPECIES

4.1 Family Psychidae

***Liothula omnivora* Fereday 1878**

This widespread and common casemoth is occasionally found on both *Peraxilla colensoi* and *Ileostylus micranthus*. The grey-brown larval cases grow up to 5 cm long.

***Reductoderces* sp. (*microphanes* Philpott grp)**

Smaller case-bearing larvae of *Reductoderces* sp. (*microphanes* group) have been found several times feeding on the flowers of *I. micranthus* in Woodhaugh Gardens, Dunedin. This small species is predominantly algal-feeding as a larva. The cases are grey-brown in colour and up to 6.5 mm in length and 2 mm wide.

4.2 Family Tortricidae

Additionally, a suite of well known polyphagous leaf-tying moths (family Tortricidae) have been commonly recorded from various mistletoe species (Table 2). Because these moth species do not completely depend on mistletoe for their survival, they may pose a threat by defoliating mistletoe as they may build up to high population numbers on other hosts, then hit mistletoe. Such infestations have so far not been reported (but see de Lange 1996).

TABLE 2. TORTRICID MOTHS RECORDED FEEDINGS ON VARIOUS MISTLETOE SPECIES

Peraxilla spp.	*Ileostylus micranthus*	*Tupeia antarctica*	*Korthalsella lindsayi*
Catamacta gavisana *Apoctena flavescens* *Ctenopseustis obliquana* *Planotortrix excessana*	*Ctenopseustis herana* *Ctenopseustis obliquana* *Cnephasia jactatana* *Planotortrix excessana*	*Epalxiphora axenana* *Pyrgotis plagiatana*	*Ctenopseustis obliquana* *Harmologa oblongana*

5. CONCLUSIONS

New Zealand mistletoes, particularly *Ileostylus micranthus*, *Peraxilla colensoi* and *P. tetrapetala* are the only host plants for a small number of native moths in the families Geometridae and Yponomeutidae, and also support a small number of polyphagous leafrollers (Tortricidae).

Damage by larvae of these moths is a normal occurrence, especially for the specialist moth species. The polyphagous moth species have the potential to do more damage to mistletoe foliage as they are not solely reliant on mistletoes but may be subject to more extremes of abundance and expand, in periods of peak abundance, to mistletoes.

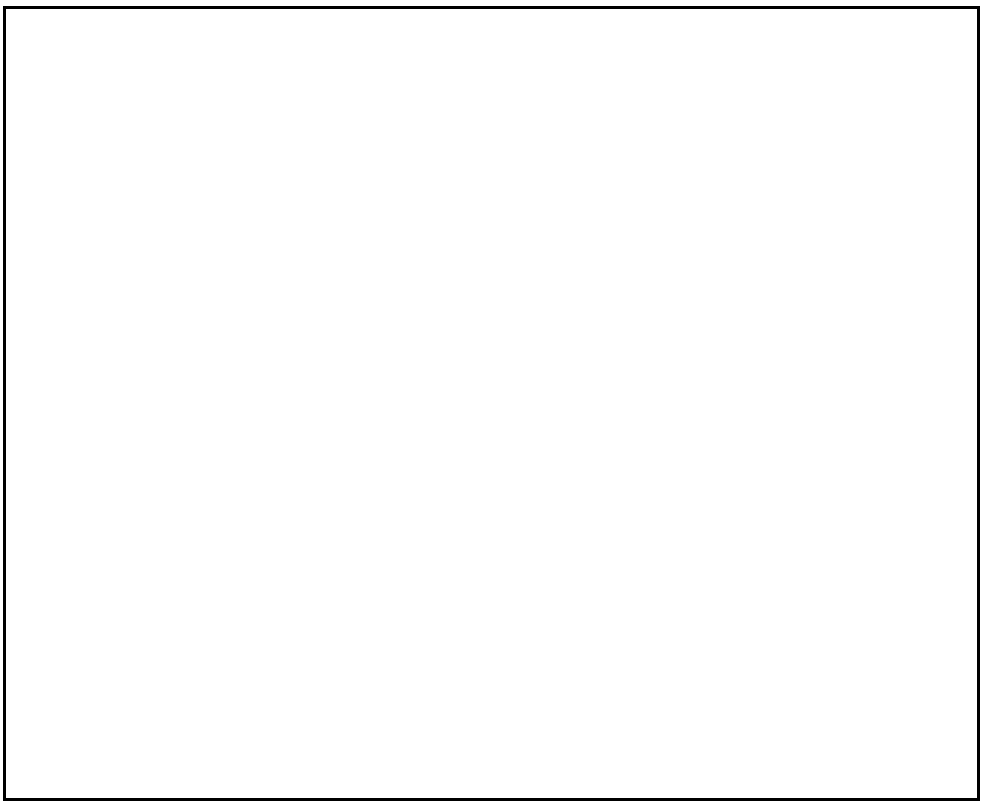

FIGURE 5. *Zelleria sphenota* ADULT.

At present, extensive moth records and personal observation of the plant species indicate that mistletoes are abundant and widespread in the southern half of the South Island.

More work needs to be done to:

1. verify the host range of *Declana griseata*;
2. sort out the taxonomy of *Zelleria* species in New Zealand, and verify their host ranges;
3. determine if *Tatosoma agrionata* is an indicator species for *I. micranthus* in the North Island;
4. investigate the possible lepidoptera fauna of *Alepis*.

These aspects would provide a base for testing the applicability of using the mistletoe moths (e.g., *D. griseata*) as indicator species of mistletoe presence and abundance in areas where it is difficult to sample on foot, and particularly if it is found that some moth species have restricted host ranges within New Zealand Loranthaceae. In the North Island the green geometrid moth *T. agrionata* may be a useful species to monitor, as the presence of the moth must indicate a reasonable quantity of the host because the moth will disappear long before the mistletoe does.

6. ACKNOWLEDGMENTS

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Population biology of Australian mistletoes

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SUMMARY

The reproductive biology and population ecology of Australian loranthaceous mistletoes is reviewed. The importance of avifauna as the primary dispersal vectors for mistletoes is discussed, along with the crucial role they play in seed germination and host selection.

1. INTRODUCTION

Australia has 86 species of mistletoe (Loranthaceae, 72 species; Viscaceae, 14 species; Barlow 1984, 1992). All are native, and one or other species occurs in virtually every mainland shrubland, woodland and forest habitat, including desert scrub, rainforest and mangroves. Many species are common and conspicuous, and a few damage and kill host trees in local infestations in farming districts and near towns and settlements. Several studies on the population biology of Australian mistletoes provide comparisons of mistletoe ecology that may be relevant to the New Zealand context. These are reviewed below.

2. REQUIREMENTS FOR SEEDLING ESTABLISHMENT

Mistletoes are obligate parasites and must establish on the live branch of a compatible host species. Infection experiments have been conducted with *Amyema quandang* and *A. miquelii*, by harvesting large numbers of fruits from maternal plants, breaking the ectocarp and removing the diaspore, briefly sucking or rubbing excess viscin from the diaspore ("seed"), and placing the seeds on live branches of host trees (Reid 1987, Yan & Reid 1995). Seeds are placed on dead host branches at the same time in order to determine the time required for seedling establishment on live branches. Reid (1987, 1991) conducted infection experiments with *A. quandang* on its slow growing long-lived host, western myall (*Acacia papyrocarpa*). Maximum establishment (33%) after 6 months occurred on small branches 3–4 mm in diameter, with no establishment on branches >16 mm in diameter. In the case of four cohorts of *A. miquelii* seedlings on eucalypt hosts, maximum establishment (60–88%) after 5 months occurred on branches 7–20 mm in diameter (Yan & Reid 1995).

Reid, N. Population biology of Australian mistletoes. Pp. 133–137 *in* de Lange, P.J. and Norton, D.A. (Eds) 1997. New Zealand's loranthaceous mistletoes. Proceedings of a workshop hosted by Threatened Species Unit, Department of Conservation, Cass, 17–20 July 1995.

3. AVIAN DISPERSAL

About 16 bird species have been recorded feeding on mistletoe fruit and are potentially legitimate dispersers of mistletoe in Australia (Reid 1986). A further 17 species recorded feeding on mistletoe fruit are almost certainly seed predators. Considerable work is required to determine if a bird species is a legitimate seed disperser. The evidence to date suggests that only three Australian bird species are undeniably involved in mistletoe dispersal: mistletoebird (*Dicaeum hirundinaceum*), painted honeyeater (*Grantiella picta*) and spiny-cheeked honeyeater (*Acanthagenys rufogularis*) (Liddy 1983, Reid 1986, 1989, Yan 1993), although several other honeyeater species are probably dispersers as well.

4. AVIAN DISPERSAL QUALITY: DISPERSER EFFICIENCY

The quality of seed dispersal performed by a bird has two components (Reid 1989): disperser efficiency is the probability that a seed dispersed by the vector will lodge in a safe site and germinate. Reid (1989) compared the dispersal of *A. quandang* by mistletoebirds and spiny-cheeked honeyeaters in arid western myall woodland. The mistletoe fruits throughout the year but produces most fruit in summer, when spiny-cheeked honeyeaters consume large quantities of fruit. Mistletoebirds are present in low numbers and consume *A. quandang* fruit throughout the year. Mistletoebirds disperse *A. quandang* seeds by depositing defecated seeds on the branch on which they are perched. Spiny-cheeked honeyeaters defecate *A. quandang* seeds normally, the seed string either falling to the ground or lodging below on intervening substrates. The net result of these two contrasting dispersal behaviours is somewhat similar. Mistletoebirds disperse only 7.7% of all defecated *A. quandang* seeds to live western myall branches because they often defecate on mistletoe or dead branches. Spiny-cheeked honeyeaters disperse only 10.8% of defecated *A. quandang* seeds to live western myall branches because many seeds fall onto the ground or dead branches.

Mistletoebirds and spiny-cheeked honeyeaters disperse 0.7% and 1.0%, respectively, of *A. quandang* seeds to 3–4 mm diameter branches, and 5.9 and 1.4%, respectively, of *A. quandang* seeds to the full range of western myall branch diameters (1–16 mm) capable of being infected. Thus the two birds are similarly efficient at dispersing seeds to the branch diameters most susceptible to infection, but mistletoebirds are more efficient dispersers to the full range of susceptible branch diameters.

5. MISTLETOE SEED TREATMENT IN THE GUT OF DISPERSERS

The treatment of soft mistletoe seeds in the gut of potential dispersers can be an important determinant of germination and early seedling growth (McKey 1975), and thus of disperser quality. Murphy *et al*. (1993) used captive birds to compare the gut passage time of *A. quandang* seeds in mistletoebirds and spiny-cheeked honeyeaters. The gut passage time in mistletoebirds (9 g) varied between 3:06 and 38:03 min, with a mean of 13:40 min. In spiny-cheeked honeyeaters (44 g), gut passage time varied

between 15:49 and 84:10 min, with a mean of 40:34 min. Mistletoebirds have a remarkably short digestive tract and reduced gizzard, mistletoe fruits passing directly from the oesophagus to the intestine (Richardson & Wooller 1988). Spiny-cheeked honeyeaters, on the other hand, have an unspecialised digestive tract, and mistletoe fruits pass through the muscular gizzard. The differences in size and digestive tract specialisation account for the large difference in gut passage time between the two bird species.

The effect of passage time on germination of *A. quandang* seeds was measured when seeds defecated by the two bird species were inoculated on western myall branches (Murphy *et al*. 1993). Germination percentage of seeds defecated by mistletoebirds (85%) and spiny-cheeked honeyeaters (81%) did not differ significantly 1 week after inoculation. However, 5 months after inoculation, a significantly greater proportion of seedlings had established from seeds passed by mistletoebirds (43%) than from seeds defecated by honeyeaters (31%). Thus the longer passage time of seeds in the gut of honeyeaters had a small but significant negative effect on subsequent seedling establishment in *A. quandang*.

6. AVIAN DISPERSER QUALITY: DISPERSER EFFICACY

Disperser efficacy is the proportion of seedlings in a population that a particular seed vector is responsible for disseminating (Reid 1989). Because of the contrasting dispersal behaviours of mistletoebirds and spiny-cheeked honeyeaters, the bird species responsible for dispersing young *A. quandang* seedlings in western myall canopies can be identified with a high degree of certainty. By searching tree canopies for seedlings, Reid (1989) found that four to five times more established seedlings (>6 months of age) were dispersed by spiny-cheeked honeyeaters than mistletoebirds. Notwithstanding the slight negative effect of honeyeater dispersal on seedling establishment, this result suggests that spiny-cheeked honeyeaters are more effective dispersers of *A. quandang* than mistletoebirds, due to the much higher density of honeyeaters than mistletoebirds in western myall woodland.

7. LONG DISTANCE DISPERSAL

Mistletoe seeds can potentially be dispersed over large distances in the digestive tract of a disperser. In the case of *A. quandang*, the maximum retention time of a seed is 84 min in the gut of a spiny-cheeked honeyeater (Murphy *et al*. 1993). Assuming an average flight velocity of 10 m s^{-1}, an *A. quandang* seed might be dispersed up to 50 km in one event. These observations beg the question, what is the optimal dispersal distance of a mistletoe seed?

To answer this question, we collected a large quantity of *A. quandang* fruit in January–February 1991 and deployed 24 seeds on each of 7 western myall trees at each of 8 sites up to 320 km from the maternal mistletoes on two separate occasions (Z. Yan & N. Reid, unpubl. data). About 1 yr later, we found that maximum establishment of both seedling cohorts (21–22%) was highest at site 1 where the fruit had been collected, declining to 0–2% establishment at sites >200 km away. Establishment success is clearly maximised if

seeds of *A. quandang* are dispersed over short distances, and long distance dispersal is heavily selected against.

Two sorts of factors might explain the above result. Environmental factors (e.g., temperature, predators) might vary sufficiently between sites to reduce establishment at increasingly distant sites. Alternatively, the local mistletoe population might be genetically adapted to infect local western myall hosts, and with increasing distance, might be less able to infect genetically distinct host populations. Whichever explanation is correct, the fact remains that optimal dispersal distance for *A. quandang* is <30 km in arid western myall woodland.

8. FUTURE STUDIES

Mistletoes are usually distributed across landscapes in a patchy manner (Reid & Lange 1988, Norton *et al*. 1995). A number of factors may be involved. First, some trees may be genetically more susceptible to mistletoe infection than other individuals in a population. Second, some trees may have environmentally-determined attributes that predispose them to infection: for instance, they may be located in run-on sites in the landscape and have a more favourable water and nutrient status than their neighbours. Third, disperser behaviour may influence the sorts of trees that are infected. Birds may prefer large trees, a certain density of trees or particularly dense trees for singing or nesting. Fourth, proximity to existing sources of fruiting mistletoe is likely to influence a tree's chances of being infected. All of these factors may be important in determining the pattern of mistletoe distribution across a landscape in time and space. Understanding the reasons for patchy mistletoe distributions has become a major question for researchers interested in mistletoe conservation and management. In Australia, where pest mistletoes need to be managed, landscape models of mistletoe dynamics (Lavorel *et al*., in prep.) need to be improved to better predict mistletoe infestation in agricultural landscapes and the patterns of remnant tree distribution that minimise pest mistletoe buildup. In the North Island of New Zealand, where mistletoe conservation efforts are increasingly focussed on isolated small stands of host trees, information about the sorts of trees that make the best hosts will be crucial to safeguarding threatened populations of mistletoes in the medium term.

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