Part 3 Threats to New Zealand mistletoes

Evidence for the impacts of possums on mistletoes

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SUMMARY

The evidence is updated on the impacts of introduced brushtail possums (*Trichosurus vulpecula*) on New Zealand's loranthaceous mistletoes. It is concluded that possums eat mistletoes and they probably kill both individual plants and populations of mistletoes. Management practices that prevent possums reaching mistletoe plants have produced improvements in mistletoe growth and abundance. Because it is desirable to obtain further evidence of the impacts of possums, managers of mistletoe habitats should endeavour to incorporate a research component into their work to enhance mistletoe populations.

1. INTRODUCTION

The work of Wilson (1984) was the first published study on the impacts of the introduced brushtail possum (*Trichosurus vulpecula*) on a population of New Zealand mistletoes. Ogle & Wilson (1985) extended this to a national review, collating published and unpublished sources on the distribution and abundance of loranthaceous mistletoes and related these to the occurrence and impacts of possums. Much of the evidence was anecdotal and the case pointing to possums as the cause of mistletoe decline was based more on indirect evidence than on experiments or direct observations of possums destroying mistletoe plants. Nevertheless, widespread mistletoe decline was demonstrated and possums were identified as the main (but not the only) cause.

Ten years on from Ogle & Wilson's (1985) review, the case against possums has been widely accepted, especially in "popular" articles and books (Barlow 1987, James 1990, Webb *et al*. 1990, Clark 1993). However, some of the key questions posed by Ogle & Wilson (1985) remain largely unanswered. These questions include "why are mistletoes not more common on certain islands with suitable host plants but without possums? If possums were involved in the presumed extinction of *Trilepidea adamsii* then why did that mistletoe apparently disappear from Great Barrier Island, which has no possums? Why do leafy mistletoes persist in some eastern and southern parts of the South Island, despite the presence of possums?"

The mistletoe workshop in July 1995 provided a stimulus for another review of this subject.

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2. THE EVIDENCE FOR POSSUM IMPACTS ON MISTLETOES

Evidence of possum impacts on mistletoes can be allocated to one of three main groups: (1) direct evidence of damage to mistletoes by possums, (2) the coincidence of mistletoe decline with possum distribution, in time and place, and (3) changes in mistletoe plants after protection from possums.

2.1 Direct evidence of damage to mistletoes by possums

Direct evidence of possums damaging individual mistletoe plants can be grouped into three categories:

1. Direct observations of possums on mistletoes

Very few records exist of people observing possums in the act of eating mistletoes in the wild. A recent report was by Terry Farrell and Glen MacDonald of West Coast Conservancy, Department of Conservation. While spotlighting at Creswicke Flat in the Landsborough Valley, south Westland in 1991, they observed possums eating leafy material from several *Peraxilla colensoi* in beech trees (C. Miller, pers. comm., June 1995).

In addition to eye witness accounts, direct evidence could include photographs or video film. One published record which seemed promising was a coloured photograph of a possum on a flowering plant of *P. colensoi* in Clark (p. 30, 1993). However, the photographer, Rod Morris has told me (pers. comm., 1995) that the possum was a pet animal placed in the mistletoe for the purpose of the photograph.

2. Damage on mistletoe plants

A number of the Conservancy reports in these proceedings record damage to mistletoes which was identified as being caused by possums (e.g., Barkla 1997, Walls 1997). In ascribing damage on mistletoe plants to possums, it is important to distinguish that caused by possums from that which results from other causes, such as insects (de Lange 1997, Patrick & Dugdale 1997), or dieback from diseases (Johnston *et al*. 1994).

3. Presence of mistletoe fragments in possum gut contents

The only known finding of a New Zealand mistletoe in a gut analysis of possums is by Owen & Norton (1995). In that study, *P. colensoi* was a common component of the South Westland forest but a minor component of the diets of the possums analysed.

2.2 The coincidence of mistletoe decline with possum distribution, in time and place

Much of the 1985 review of the impacts of possums on mistletoes (Ogle & Wilson 1985) was based on examples of mistletoe decline following the arrival of possums and the persistence of mistletoes in possum-free places. These examples are not repeated here, except where additional information is now available, such as in the case of Waitutu Forest. Interest in this topic has prompted several people to draw my attention to further instances, which can be divided into present and past distribution patterns of mistletoes and possums, on the mainland and on islands.

1. Present distribution of mistletoes compared with possums on:

(i) The mainland: One of the largest parts of the New Zealand mainland which was free of possums until the past decade was the extreme southwest corner of the South Island, more specifically western Waitutu Forest and southern Fiordland. The great abundance of four species of loranthaceous mistletoes in western parts of Waitutu (*Peraxilla colensoi, P. tetrapetala, Alepis flavida, Ileostylus micranthus*) was discussed by Ogle & Wilson (1985), using information from Elliott & Ogle (1984). Mistletoe presence was linked to the absence of possums, resulting from the barrier to their westward movement posed by the Wairaurahiri River.

W. Baxter (pers. comm. June 1995) of the Tuatapere Field Centre, Department of Conservation reports:

> "possums have probably been in the area between Waitutu and Wairaurahiri [Rivers] for about 12 years, being concentrated around the coastal margin and river courses. I believe they entered the area to the west of Waitutu in about 1986, but numbers did not build up until the population increased in the area to the east and forced animals across the [Wairaurahiri foot]bridge. We noticed browse on mistletoe species near the Grant Burn and 600 feet above the Long Burn (Slaughter Burn). Possums have probably spread inland from the coastal margin, but are still in very low numbers. A DOC survey in 1994 found sign all along the western shore of Poteriteri, but in 1995 we found no evidence. Animals are probably spreading south from the area around the Princess Burn, Hauroko... ."

Mistletoes are very rare in the Wellington region. Moore (1987) suggested that the presence of at least 22 plants of *I. micranthus* in an urban park surrounded by houses in Upper Hutt was the result of "partial, or even complete, isolation from browsing by the [Hutt] valley's burgeoning possum population". Ogle & Wilson (1985) gave similar cases, where local populations of mistletoes occurred in places where possums are likely to be uncommon or absent, or heavily controlled.

(ii) Geographic islands: Possum-free islands with mistletoes include:
D'Urville Island: *A. flavida, I. micranthus, P. tetrapetala, T. antarctica* (Ogle & Wilson 1985)
Islands in Lake Waikareiti: *P. colensoi, P. tetrapetala* (W. Shaw, pers. comm. Feb. 1996)
Little Barrier Island: *P. tetrapetala* (on *Quintinia serrata*, pers. obs. Jan. 1991)
Pigeon Island in Lake Wakatipu: *Peraxilla* spp. (Simpson 1997)

There are many possum-free islands around New Zealand which also lack mistletoes, but which do have suitable host plants. Why mistletoes do not occur more widely on islands is unknown. In most instances, such islands have never been known to have mistletoes, but there are at least two exceptions to this. Both Great Barrier and Waiheke Islands had the presumed extinct mistletoe *Trilepidea adamsii* (Norton 1991). Because possums have never been present, they cannot have contributed to the extinction of *T. adamsii* on these islands (Ogle & Wilson 1985, Norton 1991).

2. The previous abundance of mistletoes on the mainland, where there are few or none today:

Dorrien-Smith (1908) traversed the Mt Arthur area of northwest Nelson and wrote:

> "At about 3000 feet I noticed scarlet patches on the beech trees and these turned out to be the scarlet-flowered mistletoe, a lovely sight, which as we got higher became more frequent and perfectly gorgeous".

Above the Cobb Valley he reported:

> ".......an open glade covered in Celmisias and the beech trees all aglow with the scarlet-flowered mistletoe; it was a magnificent sight, and brighter by far than any Metrosideros".

Returning via Mt Peel over the Tableland he reported :

> "The scarlet mistletoe was more gorgeous than ever...".

These notes of Dorrien-Smith (1908) make it clear that a *Peraxilla* species was at least locally common or abundant in northwest Nelson's continuous forest tracts, where loranthaceous mistletoes are all but extinct today (Druce *in* Ogle & Wilson 1985, Courtney 1997). *P. colensoi* still occurs on scattered silver beech trees in pasture inland of Nelson-Motueka. The extinction of *Tupeia* and *Alepis* in Golden Bay is mentioned by Courtney (1997).

At about the same time that Dorrien-Smith (1908) saw abundant scarlet mistletoes in northwest Nelson, Townson (1906) reported similar phenomena in North Westland:

> "I have seen trees fairly ablaze with the scarlet flowers of *Elytranthe (Peraxilla) tetrapetala*"

At Giles Creek (p. 387) and at Blackwater they were:

> "abundant from sea level to 2000 feet" (p. 420).

In his summary of the distribution of mistletoes in North Westland, Townson (loc. cit.) described *P. colensoi* as being a common parasite of beeches, *I. micranthus* as being "abundant throughout", and he gave one location for *A. flavida*.

On the Waitaanga Plateau in North Taranaki in the mid-1930s, Thomson (1979) reported:

> "I discovered in those....silver beech forests of inland Taranaki, a swarm of what were obviously *Elytranthe* hybrids. There was a beautiful colour gradation from the red *E. [Peraxilla] tetrapetala* to the yellow *E. [Alepis] flavida*."

It is unlikely that hybridism was the cause of the variety of flower colours that Thomson observed (de Lange *et al* 1997). However, there is no doubt that he saw mistletoes in a place where red mistletoes are rare and yellow mistletoe are unknown today (Barkla and Ogle 1997).

Ian Powell's records of *P. tetrapetala* in the Tararua Ranges were quoted in part by Ogle & Wilson (1985). The full text, which Powell read to me in 1985 from his diaries, is as follows:

> "Christmas 1924: drove Masterton to base of Holdsworth; five men, two women, leaders Bill Wilson, Bert Tregear. Along track saw red mistletoe, large branch gathered and taken to upper mountain house. On way out along cattle track from Totara Flat to Dalefield passed a lot of mistletoe *en route* on beech."

The following year, Powell's diaries reported:

> "Christmas 1925: during Tararua crossing (Woodside to Otaki) saw one mistletoe under Mt Reeves. Left Tauherenikau Hut for Bull Mound and saw fallen mistletoe flowers all along track until about half-way up."

P. tetrapetala had not been seen in these areas for many years (A.P. Druce, pers. comm. 1985) until it appeared along the Mt Holdsworth track, following recent possum control (Sawyer 1997)

2.3 Changes in mistletoe plants after protection from possums

1. Host tree banding/mistletoes in cages

Over the past five years or so, many groups or individuals have protected mistletoe plants from possums by banding host trees or enclosing individual mistletoe plants in cages on the host. Some are documented in the reports of Department of Conservation conservancies in these proceedings (e.g., Jones 1997, Barkla and Ogle 1997, Walls 1997, King & de Lange 1997).

In Hawkes Bay there has been a recovery of *P. tetrapetala* and *T. antarctica* "in several places following comprehensive possum control (cages and bait stations)....When a possum got into one cage it did a fair bit of damage to one *P. tetrapetala*" (Walls 1997).

In Mangaweka Scenic Reserve, a tiny shoot of *T. antarctica* arising from a warty trunk growth on lemonwood (*Pittosporum eugenioides*) was protected by banding the sloping trunk above and below the mistletoe (J. Barkla, pers. comm.). Within a year there were many additional sprouts of the mistletoe, but these have been chewed off periodically by possums (as evidenced by the type of browse sign and scratch marks), then re-grown each time. Banding of the host tree has provided only short-term protection of the mistletoe, perhaps until there is sufficient foliage to attract a possum over the metal band on the sloping trunk. Intensive trapping and poisoning of possums in this reserve has not reduced the possum population to the point that the mistletoe can grow large enough to flower.

On the western side of Lake Taupo, numerous plants of *T. antarctica* have been allowed to reach flowering size by banding the host trees (*Pittosporum tenuifolium*) (Jones 1997).

Despite possum control by trapping and cyanide poisoning in a site near Lake Hawea, J. Flemming (Simpson 1997) observed flowering of *P. tetrapetala* on only two out of 21 beech trees with the mistletoe — the two which were banded to prevent possums reaching the mistletoes.

2. Intensive possum control/eradication

Following the eradication of possums from Kapiti Island, I saw two large plants of *Tupeia antarctica* in September 1989 on lemonwood trees behind the manager's house. On the same visit, I found further mistletoes sprouting from warty growths on the trunks of karo (*Pittosporum crassifolium*), which have been identified since as *T. antarctica* (P. de Lange, pers. comm. 1995). *I. micranthus* has been recorded on Kapiti Island (I Atkinson *in* Ogle & Wilson 1985, W. Fleury, pers. comm. 1995) though it may no longer be present.

The most abundant and vigorous plants of *T. antarctica* in Wanganui Conservancy grow in a remnant of native forest incorporated into a private garden on a farm near Mataroa. The garden's owners undertake regular and intensive possum control.

3. CONCLUSIONS

There is no doubt that possums eat loranthaceous mistletoes in New Zealand, as can be deduced from dietary studies and direct observations of possums and mistletoe plants.

The conclusion that possums kill individual mistletoe plants and whole populations of mistletoes is based on the generally healthy appearance and greater abundance of mistletoes in the absence of possums and, conversely, the generally poor state of mistletoes where possums are common.

Against this pattern is the abundance of apparently healthy mistletoes in the presence of possums in parts of the eastern South Island, including the Craigieburn area. Massive regional declines in mistletoes are not just a North Island phenomenon, because they have also occurred in Nelson, north Westland, and much of Southland.

Possums are "naturally" absent from some places with mistletoes, such as islands or parts of the mainland outside their present range, or may be physically separated from mistletoes by management which excludes possums from (mostly small) places within the present range of possums. Management practices include the poisoning and trapping of possums, and protecting of mistletoe plants by cages or tree banding. There is a growing number of situations where possum control has led to a recovery of mistletoe plants.

I accept that most of the evidence which points to possums as being the cause of regional losses of mistletoes is circumstantial. No population of mistletoes has been monitored as it was eliminated by possums. However, the current evidence is so strong that we cannot afford to "wait and see" any longer. Conservation management of mistletoes should assume that possums are a major threat and further research on mistletoe/possum interactions will need to be within such management. Improved understanding of the role of possums in mistletoe declines would be achieved by:

1. Monitoring mistletoes in the eastern South Island where they are still common (monitoring should be to detect the onset of the declines which have occurred elsewhere);
2. Documenting instances of the impacts of possums on mistletoes, and the recovery of protected mistletoes; a national file of these cases should be maintained;
3. Incorporating "research by management" into the control of possums in areas with mistletoes. For example, if host trees are being banded to exclude possums, some trees with mistletoes should be left unbanded, and mistletoes monitored on banded and unbanded trees. Different levels of possum control might be done, to determine at what level there is significant protection afforded to mistletoe plants.
4. Seeking further direct evidence of possums causing damage to mistletoes through, for example, the use of an infa-red, movement-sensored video camera. Such monitoring might include previously protected mistletoe plants in an area of possum densities (P. Wilson, pers. comm. 1995).

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5. REFERENCES

Barkla, J., Ogle, C.C. 1997. Status of loranthaceous mistletoes in the Wanganui Conservancy. This volume, pp. 47–49.

Barlow, B.A. 1987. Mistletoes. *Biologist* 34, 261–69.

Clark, J.A. 1993. 1080: forest saviour or wildlife poison? *Forest and Bird* 270, 30–35.

de lange, P.J. 1997. Decline of New Zealand loranthaceous mistletoes — a review of non-possum (*Trichosurus vulpecula*) threats. This volume, pp. 155–163.

Dorrien-Smith, A.A. 1908. *Bulletin of Miscellaneous Information No 10*. Nelson Museum.

Elliott, G.P., Ogle, C.C. 1984. Wildlife and wildlife habitat values of Waitutu Forest. *Fauna Survey Unit Report No. 40* New Zealand Wildlife Service, Department of Internal Affairs, Wellington.

James, I. 1990. Possum peril. *Forest and Bird* 21(3), 30–33.

Johnston, P.R., Parkes, S.L., Beever, R.E. 1994. Report on dying mistletoes from Eglington Valley. Unpub. Landcare Research report, Auckland.

Jones, C. 1997. Status of loranthaceous mistletoes in the Tongariro-Taupo Conservancy. This volume, pp. 39–41.

King, G., de Lange, P.J. 1997. Status of loranthaceous mistletoes in the Bay Of Plenty Conservancy. This volume, pp. 35–38.

Moore, S. 1987. Mistletoes: are urban parks ideal habitats? *Wellington Botanical Society Bulletin* 43, 26–27.

Norton, D.A. 1991. *Trilepidea adamsii*: an obituary for a species. *Conservation Biology* 5, 52–57.

Ogle, C., Wilson P. 1985. Where have all the mistletoes gone? *Forest and Bird* 16(3), 10–13.

Owen, H.J., Norton, D.A. 1995. The diet of introduced brushtail possums *Trichosurus vulpecula* in a low-diversity New Zealand *Nothofagus* forest and possible implications for conservation management. *Biological Conservation* 71, 339–45.

Patrick, B.H., Dugdale, J.S. 1997. Mistletoe moths. This volume, pp. 125–132.

Sawyer, J. 1997. Status of loranthaceous mistletoes in the Wellington Conservancy. This volume, pp. 55–57.

Simpson, N. 1997. Mistletoes in Otago. This volume, pp. 75–78.

Thompson, A.P. 1979. Mountains as I see them. *New Zealand Man and the Biosphere Report No. 2*, 71–77.

Townson, W. 1906. On the vegetation of the Westport District. *Transactions of the New Zealand Institute* 39, 380–433.

Walls, G. 1997. Status of loranthaceous mistletoes in the Hawke's Bay Conservancy. This volume, pp. 51–53.

Webb, C., Johnson, P., Sykes, W. 1990. Flowering Plants of New Zealand. DSIR Botany/Caxton Press, Christchurch.

Wilson, P.R. 1983. The effects of possums on mistletoe on Mt Misery, Nelson Lakes National Park. In, P.R. Dingwall (compiler), Protection and Parks: Proceedings of Section A4e, 15th Pacific Science Congress, Dunedin, Feb. 1983. Department of Lands and Survey, Wellington. Pp 53–60.

An assessment of possum (*Trichosurus vulpecula*) impacts on loranthaceous mistletoes

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SUMMARY

While there is no doubt that possums eat mistletoes, the extinction of *Trilepidea adamsii* cannot be ascribed to possum browse. Studies of possum browse on *Peraxilla colensoi* foliage and possum diets in south Westland suggest that availability of alternative foods may limit possum impacts on mistletoes in this area. A study of growth architecture in *Alepis flavida* and *Peraxilla tetrapetala* at Craigieburn suggests that these two species may respond differently to possum browse. The results from these studies suggest that we should be cautious in ascribing decline and local extinction of loranthaceous mistletoes to possums alone

1. INTRODUCTION

One of the key problems in assessing the impacts of brushtail possums (*Trichosurus vulpecula*) on loranthaceous mistletoes is the lack of data quantifying possum browse. The exception to this is Wilson (1984) who showed a pronounced improvement in mistletoe growth and flowering following a reduction in possum numbers in part of Nelson Lakes National Park. While there are many anecdotal examples of plant dieback in response to possum browse (e.g., as summarised in Ogle & Wilson 1985), there are also several examples of apparently healthy mistletoe populations in areas with a long history of possum colonisation (e.g., at Craigieburn and in Arthur's Pass National Park).

In this paper I summarise results from three studies that help shed light on the nature of possum impacts on loranthaceous mistletoes.

2. THE EXTINCTION OF *Trilepidea adamsii*

This now extinct mistletoe was first described by Cheeseman in 1880 (Cheeseman 1881) and was recorded from eight sites in the northern North

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Island until its last record in 1954, and is now presumed extinct (Norton 1991). Various reasons have been proposed for its extinction, including possum browse, and it is tempting to interpret a drawing by Hetley (reproduced in Wilson & Given 1989, p139) as showing possum browse. Several authors have suggested that there may be a link between the decline of *Trilepidea* and the expansion of possums (e.g., Barlow & Weins 1977, Given 1981, Ogle & Wilson 1985, Wilson & Given 1989).

It appears, however, that possums were not a major factor in the decline and extinction of *Trilepidea adamsii* (Norton 1991). Three lines of evidence support this conclusion:

1. *Trilepidea* became extinct on islands where there were no possums (Waiheke and Great Barrier);
2. Browse apparent on *Trilepidea* leaves on herbarium sheets is due to insects rather than possums;
3. Possums were never abundant within the range of *Trilepidea* while it was still extant and, in fact, did not reach the Coromandel until the 1950s, well after the last record of *Trilepidea* from this area.

It would therefore seem that possums played only a minor (if any) role in the extinction of *Trilepidea adamsii*. Key factors in the decline of this taxon appear to have been habitat loss, over-collecting by botanists and reduced seed dispersal due to a loss of dispersers (Norton 1991). Ladley & Kelly (1995a,b) have suggested that a loss of pollinators may also have been a contributing factor to this extinction.

3. POSSUMS AND MISTLETOES IN SOUTH WESTLAND

Peraxilla colensoi is a common parasite on *Nothofagus menziesii* in south Westland, an area in which possums are still invading. This area has provided the opportunity to collect quantitative data on the ecology of mistletoes and the impact that invading possums have on them (Owen 1994). Based on observation elsewhere in New Zealand (e.g., as reported in Ogle & Wilson 1985), it would seem reasonable to hypothesise that mistletoes should be “ice-cream” plants for possums, and should be amongst the first species removed as possums invade an area. To test this we sought to quantify the relationship between possums and mistletoes by monitoring marked mistletoe plants and through analysis of possum diet.

Possums were liberated to the east of Haast Pass in the Makarora catchment in 1914 and reached the Pleasant Flat study site by 1950. Today this area supports a well established possum population, but one still apparently at pre-peak densities. Possums are still expanding down the Haast Valley and into the Landsborough Valley. The main study area at Pleasant Flat had not experienced any possum control operations, although intermittent trapping had occurred for a number of years.

3.1 Mistletoe browse study

The first part of this study sought to determine if possums were browsing mistletoe foliage, at what time of the year this browse occurred, what other factors impacted on mistletoe leaf area, and what the effects of these different factors were on total leaf area over the course of a year (Owen 1994).

Forty mistletoes on separate trees were located and tagged in two areas (20 in each). Ten branches (25–30 cm long) on each plant were randomly selected and tagged and the position of each leaf and its number were drawn on a diagram. Leaf health and number were assessed four times, in February, May, August and November 1993. At each measurement, leaf health was visually scored in terms of the amount of browse, and the origin of the browse (possum or insect).

Results were similar from the two sites and showed an overall increase in leaf area over the study period. Of the original leaves, 45 and 46% were lost through abscission (from the two study sites), 3 and 5% were lost through insect browse and c. 2% were lost through possum browse. Although overall possum browse was minor, it was restricted to only 7 out of 40 plants monitored, and these plants had light to heavy browse. In contrast, insect browse was spread over all 40 plants and was reasonably similar on all plants.

The seasonal pattern of leaf loss and replacement showed a net increase in total leaf area for the unbrowsed plants, but a slight loss in leaf area for the browsed plants. The difference in overall leaf area change was significant between the browsed and unbrowsed plants. The majority of possum browse was recorded in the August census, suggesting that the leaves were eaten in the period between May and August.

The major drawback of this study is that the data do not cover the full growing season, with the first measurement in February and the last in November. Clearly, there will be on-going leaf loss between November and the next February. Furthermore, the number of leaves eaten by possums was almost certainly underestimated, as it is not possible to tell if fallen leaves were totally eaten by possums or broken off the plant, or if they fell (abscised) naturally. However, the data collected suggest the following:

1. Possum impact is restricted to only a small portion of plants, but can be heavy on these. This is consistent with other studies of possum browse which show that they selectively feed on only a few individual plants (Green 1984).
2. Possum browse does have a significant impact on annual leaf budget and clearly on-going browse will result in eventual tree death as photosynthesis is unable to match respiration losses.
3. Most possum browse occurs in winter when only mature leaves are available. Possums are apparently not eating young leaves in spring. There was also evidence of similar browse patterns the previous year. It is possible that this reflects overall food availability (see below).
4. In this area the amount of leaf area loss due to possums is less than that due to insects.

3.2 Possum diet and mistletoes

The second part of this south Westland study looked at the diet of possums in the same area (Owen & Norton 1995). Here we sought to assess the contribution mistletoes made to possum diet and how this compared with the results from the mistletoe leaf area study.

Possum diet was assessed by sampling possums in February, May, August and November 1993 using cyanide poison lines. 20 possums were sampled at each time from areas adjacent (but separated by large streams) to those used for the leaf area study. Possum guts were extracted and sorted to assess the amounts of food material in the stomach — all data is expressed as % dry weights. The vegetation along the poison lines was also assessed to provide an assessment of plant biomass at the sampling site.

The most important foods in the diet were *Aristotelia serrata* and *Muehlenbeckia* species, although there were strong seasonal patterns relating to food availability. Mistletoes were relatively unimportant in possum diet. Using the measurements of vegetation abundance it is possible to calculate plant preference indices – positive indices indicate that possums are feeding on a plant proportionally more than its abundance in the forest and negative preferences indicate that it is feeding proportionally less than its abundance. Not surprisingly, the most abundant plant in these forests, *Nothofagus menziesii*, has a very strong negative preference.

The most important plants in possum diet are again *Aristotelia serrata* and *Muehlenbeckia* species together with *Rubus* species and Poaceae (grasses) – all having an annual positive preference. However, it is again clear that there are strong seasonal patterns. For example, *Muehlenbeckia* and *Fucshia excorticata* have negative preferences in winter, when they lose their leaves, while grasses are most important in winter. Insect (Dipteran) larvae are also important in possum diet in winter. Mistletoes are generally not a preferred food for possums, which agrees with the generally low impact found in the previous study.

The low importance of mistletoes may reflect differences in visibility of mistletoes in different years. Few plants flowered during the study period which could have reduced their attractiveness. But perhaps more importantly, it would seem likely that there are other food types available that do not necessitate possums climbing high into the canopy of a primarily unpalatable tree (*Nothofagus menziesii*) in search of food. Mistletoe browse in this forest may therefore reflect a combination of chance findings of mistletoe plants together with the influence of seasonal food availability patterns.

4. GROWTH ARCHITECTURE OF *Peraxilla* AND *Alepis*

In a study of crown development patterns in *Alepis flavida* and *Peraxilla tetrapetala* at Craigieburn (Powell & Norton 1994), two results have some interesting implications when considering possum impacts. First, we found that the two mistletoes, which can occur in the same host tree, had very different niches within the *Nothofagus solandri* canopy with *Alepis flavida* primarily confined to the outer branches while *Peraxilla tetrapetala* occurred mainly on the main trunks.

Second, we observed that the patterns of growth were very different between the two species. In *Alepis*, shoot extension occurs from preformed buds with little branching, giving rise to loose clumps with relatively few orders of branching. In contrast, *Peraxilla* shoot-tips usually abort, with two branches forming from submerged buds either side of the aborted bud giving rise to a highly branched shrub with many orders of branches.

It may well be that these different growth mechanisms have important implications for assessing possum impacts. For example, it would seem likely that *Alepis* will be less vulnerable to possum browsing than *Peraxilla* because plants are usually located on the outer branches and form loose clumps with long branches providing few opportunities for possums to perch and browse. However, the ability of *Peraxilla* to form new branches from submerged buds may allow this species to recover more quickly after possum browsing than *Alepis*. Clearly, more work is required to test these predictions.

5. CONCLUSIONS

1. These data show that the relationship between possum browse and mistletoe decline is not as clear cut as is sometimes suggested.
2. Possum browsing of mistletoes is going to be strongly influenced by the availability of other food sources within the forest ecosystem.
3. The response of mistletoes to possum browse will be influenced by plant architecture, and it may be that different mistletoe species show different responses to possums.
4. There is a clear need for detailed quantitative studies on possum effects on mistletoes.

6. ACKNOWLEDGEMENTS

This work draws heavily on the masters research of Hamish Owen and I would like to acknowledge his hard work in obtaining much of the data.

7. REFERENCES

Barlow, B.A., Weins, D. 1977. Host-parasite resemblance in Australian mistletoes: the case for cryptic mimicry. *Evolution* 31, 69–84.

Cheseman, T.F: 1881. Description of a new species of *Loranthus*. *Transactions of the New Zealand Institute* 13, 296–297.

Given, D.R. 1981. Rare and Endangered Plants of New Zealand. Reed, Wellington.

Green, W.Q. 1984. A review of ecological studies relevant to management of the common brushtail possum. In, A.P. Smith & I.D. Hume (editors), Possums and Gliders. Surrey Beatty & Sons, Chipping Norton, NSW. Pp 483–499.

Ladley, J., Kelly, D. 1995a. Mistletoes: Showy specialists at risk? *Forest & Bird* 278, 16–21.

Ladley, J., Kelly, D. 1995b. Explosive New Zealand mistletoes. *Nature* 378, 766.

Norton, D.A. 1991. *Trilepidea adamsii*: an obituary for a species. *Conservation Biology* 5, 52–57.

Ogle, C., Wilson, P. 1985. Where have all the mistletoes gone? *Forest and Bird* 16(3), 10–13.

Owen, H.J. 1993. Mistletoe and brushtailed possum in silver beech forest, south Westland, New Zealand. Unpublished M.For.Sc. thesis, University of Canterbury, Christchurch.

Owen, H.J., Norton, D.A. 1995. The diet of introduced brushtail possums *Trichosurus vulpecula* in a low-diversity New Zealand *Nothofagus* forest and possible implications for conservation management. *Biological Conservation* 71, 339–345.

Powell, G.R., Norton, D.A. 1994. Contrasts in crown development of the mistletoe *Alepis flavida* (Hook. f.) Tiegh. and *Peraxilla tetrapetala* (L. f.) Tiegh. (Loranthaceae) parasitic on

Nothofagus solandri (Hook. f.) Oerst., Craigieburn Ecological District, New Zealand. *New Zealand Journal of Botany* 32, 497–508.

Wilson, C.M., Given, D.R. 1989. Threatened Plants of New Zealand. DSIR Publishing, Wellington.

Wilson, P.R. 1984. The effects of possums on mistletoe on Mt Misery, Nelson Lakes National Park. In, P.R. Dingwall (editor), Proceedings of Section A4E, 15th Pacific Science Congress, Dunedin, February 1983. Department of Lands and Survey, Wellington. Pp 57–60.

Decline of New Zealand loranthaceous mistletoes — a review of non-possum (*Trichosurus vulpecula*) threats

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SUMMARY

Aside from possums (*Trichosurus vulpecula*), other factors which could be responsible for loranthaceous mistletoe declines are briefly reviewed. It is concluded that the decline of New Zealand representatives of this family is much more complex than has been hitherto suggested. Factors such as insect browse, over-collecting, habitat and host loss are discussed. The loss of *Trilepidea adamsii* provides an abject lesson for those trying to protect regionally depleted mistletoe populations.

1. INTRODUCTION

The cause of the decline in abundance of New Zealand loranthaceous mistletoes has been the focus of considerable debate in recent years (de Lange & Norton 1997), although little has been published on the subject (Ogle & Wilson 1985, Ladley & Kelly 1995). The principle cause of mistletoe decline, it has been argued, is the Australian brush-tailed possum (*Trichosurus vulpecula*) (Ogle & Wilson 1985, Ogle 1997). This assertion has invariably been translated into the need to eliminate or reduce possum levels in the vicinity of mistletoe populations. While it is clear that this action has achieved some success (Walls 1997), it is also apparent that in areas where possum levels are low or absent mistletoes are still declining and *vice versa* (Ladley & Kelly 1995, P.J. de Lange, pers. obs.). In these areas, and elsewhere in the country, it is becoming more obvious that many factors other than possums are contributing to the national decline of leafy mistletoes. This paper reviews some of these.

2. FUNGAL DISEASES

At least 9 fungi have been recorded in association with dead or dying loranthaceous mistletoes (Table 1).

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de Lange, P.J. Decline of New Zealand loranthaceous mistletoes — a review of non-possum (*Trichosurus vulpecula*) threats. Pp. 155–163 *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. FUNGI ASSOCIATED WITH NEW ZEALAND LORANTHACEOUS MISTLETOES.

FUNGI	HOST	FUNGAL HABIT
Diaporthe sp.	*Peraxilla colensoi*	Saprophyte
Diaporthe sp.	*Peraxilla tetrapetala*	Saprophyte
Fusarium sp.	*Tupeia antarctica*	Pathogen
	Peraxilla colensoi	Pathogen
Lecostoma sp.	*Peraxilla tetrapetala*	?Saprophyte
Meruliopsis corium	*Peraxilla colensoi*	Saprophyte
Phyllosticta sp.	*Ileostylus micranthus*	Pathogen
Stereum vallereum	*Ileostylus micranthus*	?Saprophyte
Tubulicrimis subalutacea	*Peraxilla colensoi*	Saprophyte
Valsa sp.	*Peraxilla* sp.	?Pathogen

Of those listed, only three have been identified as possible pathogens, the most significant of which is a species of *Fusarium*. The classic symptoms of *Fusarium* is the sudden wilt and total collapse of apparently healthy plants. This fungus has been implicated in the death of *Tupeia antarctica* at the Omori Scenic Reserve, Lake Taupo (although both host and mistletoe appear to have been infected, and it is not clear which was infected first) and a similar, probably identical, *Fusarium* has been isolated from dying *Peraxilla colensoi* collected from the Ery Reserve in Otago (P. Buchanan, pers. comm. 1995). While it is clear that some fungi have been associated with, and may even cause localised declines in loranthaceous mistletoe populations, it is less clear whether these declines are natural events or part of a more widespread "die back" phenomena (P. Buchanan, pers. comm. 1995). Nevertheless, it is quite obvious that when mistletoe populations are already extremely localised, any fungal outbreak — be it natural or otherwise — is potentially serious (G. Loh, pers. comm. 1995).

Unfortunately, while our knowledge of the fungal associations and pathogens of New Zealand loranthaceae remains poor (E.H.C. McKenzie, pers. comm. 1995), we are in no position to distinguish between those fungal attacks which are truly harmful to mistletoes or those which are a secondary (or otherwise) symptom of an already stressed host/mistletoe relationship. Also, because systematic knowledge of New Zealand fungi is far from complete, we cannot always be certain which of our fungi are indigenous or adventive (P. Buchanan and E.H.C. McKenzie, pers. comm. 1995). It is even possible that some of fungi associated with our mistletoes could be threatened (E.H.C. McKenzie, pers. comm. 1995). Therefore, any anticipated control measures *must* first identify the fungal species involved to avoid the very real risk of eliminating a non-threatening or otherwise endemic taxon. To help rectify this problem the staff of Plant Diseases Division, Landcare Research, Auckland would be keen to receive fresh material of any mistletoe suspected to have been infected by fungi.

3. INSECT PREDATION

If our knowledge of fungal/mistletoe associations is poor, what we know about the invertebrate fauna of our loranthaceous taxa is little better. Like the situation described above, we are hardly in any position to determine which invertebrates are damaging to mistletoe health, which are indigenous, and which are serious pests. Therefore, as with fungi, any control measures taken *must* first accurately identify the nature of the pest.

The following review pulls together what information I have been able to find on invertebrates associated with New Zealand mistletoes.

3.1 Lepidoptera

Although our knowledge of the insect fauna associated with our loranthaceous genera is generally poor, we do know that some loranthaceous genera — especially *Ileostylus* — are important hosts for a range of monophagous moths (Patrick & Dugdale 1997). It is also well known that mistletoes are favourite host plants for a wide range of polyphagous lepidoptera. Patrick & Dugdale (1997) provide a detailed account of these taxa, and for the purposes of this paper I wish only to examine the consequences of excessive browse by our lepidoptera.

Obviously, the survival of those moths specific to mistletoes requires healthy populations of suitable host. It is therefore conceivable that in situations where mistletoe numbers are seriously reduced, host-specific moths could eliminate their food plant, thus placing themselves, as well as their host plant, at risk of local extinction.

While I have no evidence that this has happened with mistletoe-specific species, the potential for it to happen is certainly real (J.S. Dugdale, pers. comm. 1995), and the alternative situation, where an polyphagous species can seriously damage an already stressed mistletoe population, can also occur. For example, on Kapiti Island, a polyphagous species — *Eplaxiphora axenana* — is severely defoliating plants of *Tupeia antarctica*. Unfortunately, this mistletoe population is extremely small, stressed through a change in local habitat, and failing to recruit through an apparent sex imbalance. While the moth can switch to another food plant, the long-term prospect for *Tupeia* on Kapiti is not so certain and regional extinction is quite possible, unless the moth is controlled. In a similar situation I have also observed severe browse damage to *Alepis* plants at Mavora Lakes, Southland. The culprit appears to be an unidentified species of geometrid (B.H. Patrick, pers. comm. 1995). While the effect of this moth on the extremely large Mavora Lakes population of *Alepis* is probably minimal, who knows what effect a similar outbreak would have on the already restricted and residual population of this species at Tongariro National Park?

Similarly, another unidentified moth, probably a geometrid (B.H. Patrick, pers. comm. 1995), selectively browses the anthers and stigma of developing *Peraxilla colensoi* flowers, resulting in serious damage to flowering *P. colensoi* at Tuatapere Scenic Reserve, Southland (P.J. de Lange, pers. obs.). A similar or identical species may be responsible for the browsing of *P. colensoi* flowers at Mokau, Te Urewera, (pers. obs.) and at Matawai, near Gisbourne (D. King, pers. comm. 1993). Although the *P. colensoi* population at Tuatapere is large, those at Mokau and Matawai are not, and the action of this moth may have significantly affected the fruit set at these locations (D.R. King, pers. comm. 1995).

3.2 Other Insects

Aside from moths, what other insects have been observed feeding on loranthaceous mistletoes? I have been unable to assemble many specific records. Nevertheless, it is apparent that the semi-circular chews of the leaf lamina, which at times can severely damage mistletoe plants — especially *Alepis*, *Ileostylus* and *Peraxilla* — are the feeding marks of either stick insects or weevils (species unknown)[1], and not possums — as has been suggested by some field workers (B.D. Rance, pers. comm. 1995). While the number of species and the full extent of their damage in large tracts of indigenous habitat can be difficult to gauge, the effect of insects on localised populations are more readily assessed.

In the Wellington Region, two populations of *Ileostylus micranthus* at Upper Hutt and Waikanae have recently undergone dramatic declines. The cause appears to be severe predation by leaf and stem sucking insects such as scale and thrips.

In this case the insects involved are the introduced common greenhouse thrips (*Heliothrips haemorrhordalis*), soft brown scale (*Coccus hesperidum*) and black scale (*Saissetia oleae*). The greenhouse thrips is a small communal insect which causes the characteristic silver mottling of the leaves of many common garden ornamentals (N. Martin, pers. comm. 1995). It is commonly found on broad-leaved hosts, which provide adequate shelter and moisture, conditions considered ideal for these insects (C. Green, pers. comm. 1995). Thrips are usually found on the undersides of foliage and have been recorded from a number of indigenous genera, especially *Metrosideros*.

Both black and brown scale cover the branches and leaves in small disc-shaped brown pustules. Over time the scale infestations often become covered in sooty moulds, which thrive on the waste products and excess sap left by the insects. Thus a serious scale infestation often results in the smothering of associated host foliage by moulds, thereby causing reduced photosynthetic ability. Often the ailing plant is subject to further damage from another sap sucking insect, a species of mealy bugs (possibly the introduced *Pseudococcus longispinous*). Both scales and mealy bugs are well known pests of many garden ornamentals and can be serious pests of many indigenous ferns and shrubs (Hawke 1995).

At Upper Hutt (Benge Park) and Waikanae, two small urban populations of *Ileostylus* have been infected by thrips and brown scale derived from adjacent gardens. I have also observed mealy bugs associated with the more seriously damaged plants at Benge Park. Of these pests, thrips appear the most damaging. Their feeding behaviour quickly results in foliage loss and, if untreated, the death of the host plant. Over the last two years many thrips infested *Ileostylus* at Benge Park have died (D. Merton, pers. comm. 1994). Unfortunately, exact numbers of deaths have not been kept, and it is not always clear if thrips were the sole factor in these plant losses (see later).

While the association of thrips with garden ornamentals may place urban mistletoe populations under significantly greater threat than more isolated

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[1] Recently I collected a weevil associated with seriously insect-browsed *Ileostyllus* at Pukepuke Road, near Auckland. The weevil was identified by B.H. Patrick (pers. comm., 1995) as an Australian species *Asynonychus cervinus*.

locations, the recent infestation by thrips of a solitary *Ileostylus* at Carter's Bush, near Carterton in the Wairarapa, suggests that greenhouse thrips can cover considerable distances with minimal dependence on "exotic" food sources. The result of their attack on the Carter's Bush plant was its near total collapse (T. Harrington, pers. comm. 1995). The severity of these attacks on *Ileostylus* is quite unusual, as thrips usually only partially damage the host (N. Martin, pers. comm. 1995). Possibly the effect of thrips on *Ileostylus* is enhanced by the ecology of this mistletoe. *Ileostylus* favours well lighted situations, often parasitises small-leaved hosts, and like other loranthaceous taxa, *Ileostylus* needs to transpire at twice the rate of the host to draw up nutrients from the host xylem. All these attributes render *Ileostylus* a most suitable host for thrips (C. Green, pers. comm. 1995). Recent (1995) collections of *Ileostylus* from the Hundalees, Conway River and Nelson sent to me by Graeme Jane all harbour moderate to serious infestations of greenhouse thrips, suggesting that this insect is now widespread within national populations of this mistletoe.

Unlike thrips, I have only observed black and brown scale in any abundance at the Benge Park site. These scales, while apparently causing ill thrift and some leaf drop, do not appear to have the same debilitating effect that thrips do. However, it is not always possible to single out the damage caused by scales, as most occurrences are in association with thrips and other invertebrates. For similar reasons I currently have insufficient observations on the role of mealy bugs to state what effect (if any) they may have on the health of *Ileostylus* .

Other scales have also been observed associated with *Ileostylus*. The Australian *Eriococcus atkinsonae* (the so called manuka scale) has been observed on *Ileostylus* at Greytown in the Wairarapa, and at least one other unidentified scale was associated with it. Perhaps more significantly, undated collections of *Trilepidea adamsii* made by James Adams from Pakirarahi, Coromandel are covered in black scale, another larger species (possibly a species of Ctenochiton) and the black soot associated with manuka "blight". It is tempting to speculate that these insects could have played a part of the decline of this presumed extinct species (cf. Norton 1991). Ultimately, the role of invertebrates and, specifically, introduced taxa, in the decline of mistletoes, has been little studied. Hopefully this paper will encourage further research within this area.

4. OTHER FACTORS

4.1 Over-collecting and vandalism

The apparent extinction of the mistletoe *Trilepidea adamsii*, a naturally uncommon species of northern New Zealand, was primarily caused by over-collection and associated habitat loss. In the case of this species the recognition of its primitive morphology within the world's loranthaceae by Van Tieghem in 1894; its extremely specialised habitat requirements (authors, unpubl. data), and very attractive flowers, ensured its deliberate persecution by both professional and amateur botanists, as well as those keen on floral art (Norton 1991).

Unfortunately, a recent herbarium survey by the author, D.A. Norton and B.P.J. Molloy, revealed that the fate of *Trilepidea* may not be unique, and that within parts of the country many already localised but accessible mistletoe populations have suffered through repeated over-collecting. For example, the apparent loss of *Alepis flavida* from the Raetihi Domain in the Central North Island appears to have been caused by over-collecting of an already small population[2]. In the Ohakune area, *Peraxilla colensoi* populations were subjected to repeated collecting by the same three botanists between 1946 and 1973. These actions may well have contributed to the present scarcity of *P. colensoi* in this area.

Unfortunately, for this species and *P. tetrapetala*, their attractive red flowers are much sought after for Christmas festivities. In the Nelson area, this is a particular problem, and the indiscriminate picking of flowering *P. colensoi* branches for the market, is unlikely to have a positive impact on what is an already restricted lowland remnant population of this species. Elsewhere, I have witnessed flowering branches of *P. tetrapetala* festooning a hotel foyer at Omarama, and sold as "Christmas Blooms" to Japanese tourists in the nearby public bar. However, it is not always the attractive flowering mistletoes which suffer, I have seen *Ileostylus* foliage decorating the entrance way to the dining rooms of hotels in Rotorua and Dunedin.

Acts of deliberate vandalism of host trees are also a frequent problem in some urban locations. At Benge Park, Upper Hutt, a large *Melicope simplex* carrying 10 "individuals" of *Ileostylus* was pushed over in January 1991, while other host trees at this site have continued to suffer from ring barking, nail wounds and damage associated with such an "innocent" activity as building "tree houses" by local children. In the Waikato, legend has it that the host tree supporting the last known occurrence of *Trilepidea adamsii* was deliberately bulldozed over by an irate landowner — although recent evidence suggests that this tale is rather fanciful, and it seems more likely that the host tree was cleared in ignorance along with associated shrubland for farming purposes (P.J. de Lange, unpubl. data).

This situation highlights the danger of ignorance as a major factor in mistletoe losses. At Lake Tikitapu (Blue Lake), several Chilean fire bushes (*Embothrium coccineum*) supporting *Ileostylus* and *Tupeia* were recently felled to provide better access for tourists visiting the local kiosk (author, pers. obs.). Although both mistletoes are extremely common in this area (author, pers. obs.), their presence on this host was unusual, and no other occurrences are known. It would seem that although this fact was well known to the local botanical community (Wilcox 1984), no one had mentioned this to the kiosk owner(s) who were quite oblivious of the presence of mistletoes within their motor camp (P.J. de Lange, unpubl. data). In Wakefield, Nelson a large oak (*Quercus* sp.) supporting *Peraxilla colensoi* was recently "trimmed" by Telecom, effectively removing the only known recent example of this unusual association (J. Ladley, pers. comm. 1995). Obviously, such impacts as these will have a much greater significance where mistletoe populations are already severely fragmented, or where the species concerned demonstrates high host specificity.

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[2] This species has since been relocated at Raetihi, as two small plants high in the branches of beech trees bordering the domain (J. Barkla, pers. comm. 1996.).

For example, in the Auckland Region *Ileostylus* is almost exclusively associated with totara (*Podocarpus totara*). At Middleton Road, Hunua, a single large totara supporting *c*. 150 *Ileostylus* was recently (1994) felled by the landowner, who did not know of the mistletoe's presence, despite the tree being well known to local botanists (A. Dakin, pers. comm. 1995). Similar losses occurred in the Waitakere Ranges when the reservoir dams near Huia were constructed, drowning several large totara trees supporting this species (B.P. Segedin, pers. comm. 1995). While on a national level the losses of this common mistletoe may seem insignificant, within the Auckland area these actions have helped contribute to the near regional extinction of this species (de Lange 1997).

4.2 Longevity and host stress

The long term effects of New Zealand loranthaceous mistletoe parasitism on the longevity and "fitness"of the host tree have not, to the best of my knowledge, been studied.

However, observations do suggest that at least one species — *Tupeia antarctica* — can weaken and, in some situations, cause the premature death of the host (B.P.J. Molloy, pers. comm. 1995). This is especially evident when *Tupeia* parasitises tree lucerne (*Chamaecytisus palmensis*), whose vegetative growth it often severely retards, not infrequently killing whole branches and, eventually, the entire host. *Tupeia* may also have killed karo (*Pittosporum crassifolium*) on Kapiti Island and kohukohu (*Pittosporum tenuifolium*) at Omori Scenic Reserve, Lake Taupo, through over-exploitation of the host (author, pers. obs.).

With respect to this species, it has been observed that the practice of banding trees supporting *Tupeia* can result in a rapid proliferation of the parasite, causing increased host stress and, ultimately, death (B.P.J. Molloy, pers. comm. 1995). Obviously then, banding of hosts infected by this species should only be carried out as a short-term management solution.

I have also observed situations where specimens of *Ileostylus micranthus* have almost entirely replaced the original host foliage, to the extent that it would appear that the mistletoe has usurped the photosynthetic capacity of the host. In these situations I suspect the mistletoe is maintaining host tissue through its own carbon fixation. Invariably in these cases the greatly weakened host rarely persists for more than few years (P.J. de Lange, pers. obs.).

While the effect of excessive parasitism of mature *Nothofagus* by *Alepis* or *Peraxilla* has not been adequately documented (cf. Ladley & Kelly 1995), the effect of these species on seedling *Nothofagus* has been studied. Current information suggests that in these situations the seedling host rarely survives to maturity, because the mistletoe so severely damages the host tissue that death is inevitable (B.P.J. Molloy, pers. comm. 1995).

4.3 Habitat availability and host selection

Previous workers have commented on the range of hosts utilised by our loranthaceous genera. The most widely ranging species is *Ileostylus* (which parasitises *c*. 209 taxa), while the most specific of the extant species is *Peraxilla colensoi* (utilising 16 taxa, de Lange *et al* 1997b). The ability of the species to infect a suitable host will therefore dictate its persistence at a given site. Hence *Ileostylus* occurrences on potentially long-lived hosts such as totara (*Podocarpus totara*) are more likely to persist than occurrences on shorter-lived seral species such as five finger (*Pseudopanax arboreus*). *Peraxilla colensoi*, on the other hand, is virtually restricted (D.A. Norton and B.P.J. Molloy, pers. comm. 1995) to silver beech (*Nothofagus menziesii*), which is a long-lived "climax" forest host. Therefore, populations of this species should, in theory, be more stable and persistent over time. During the compilation of herbarium data on New Zealand loranthaceous mistletoes (de Lange *et al*. 1997a), this pattern was confirmed, when it was seen that *Ileostylus* populations within shrubland zones were less likely to persist (as a result of land clearance and natural succession), while the distribution of *Peraxilla colensoi* has remained fixed in those areas of long-standing silver beech presence.

5. CONCLUSIONS

In this review I have selectively covered a number of threats whose potential significance I believe has been over-looked or down-played in the search for the cause of mistletoe decline. What has emerged is the simple fact that we know very little about the biology of our mistletoe species, the nature of their host specialisations, longevity, and associated fungi and fauna. There are other facets that could be covered, certainly we know little about the genetic component of host specificity, while the reproductive biology of our loranthaceous mistletoes requires further study — especially in relation to fruit vectors and mistletoe / host attachment requirements (cf. Ladley & Kelly 1995). Nevertheless, even without this information it is obvious that mistletoe declines continue to occur in areas where possums are restricted or otherwise absent. These declines are seen by the author as symptomatic of the overall degredation of the ecosystems these mistletoes occupy. The lesson that can be learned from this review is that our ignorance is dangerous, especially when we continue to treat the problem by use of untested management assumptions, and without the benefit of fully understanding the cause.

6. ACKNOWLEDGEMENTS

As an avowed botanist I could not have done this review without the assistance I was so generously given by Dr(s): R.O. Gardner, C. Green, B.P.J. Molloy, E.H.C. McKenzie, N. Martin, D.A. Norton, and P. Buchanan. The comments on lepidoptera are a credit to the work of B.H. Patrick, whom I also thank for his identification of a weevil specimen. I would also like to thank the following people for their comments and advice: G.M. Crowcroft, A. Dakin, J.S. Dugdale, A.E. Eagle, the late T. Harrington, D. King, G. Loh, D. Merton, B.D. Rance, B.P. Segedin and anyone else I may have inadvertently over-looked.

7. REFERENCES

de Lange, P.J. 1994. Storm damages Kaiaua mistletoe. *Rare Bits* 16: 12.

de Lange. P.J. 1997. Status of loranthaceous mistletoes in the Auckland Conservancy. This volume, pp. 27–30.

de Lange, P.J., Norton D.A. 1997. Introduction, this volume, pp. 7–8.

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

de Lange, P.J., Norton, D.A., Molloy, B.P.J. 1997b. An annotated checklist of New Zealand mistletoe (loranthaceae) hosts. This volume, pp. 83–104.

Hawke, L. 1995. Scale insects. In, B.P.J. Molloy (editor), Riccarton Bush: Putaringamotu. Riccarton Bush Trust, Christchurch. Pp 279–287.

Ladley, J., Kelly, D. 1995. Mistletoes how these showy specialists and honeyeaters need each other. *Forest and Bird* 278, 16–21.

Norton, D.A. 1991. *Trilepidea adamsii*: an obituary for a species. *Conservation Biology* 5, 52–57.

Ogle, C.C. 1997. Evidence for the impacts of possums on mistletoes. This volume, pp. 141–147.

Ogle, C.C., Wilson, P. 1985. Where have all the mistletoes gone? *Forest and Bird* 16, 10–13.

Patrick, B.H., Dugdale, J.S. 1997. Mistletoe moths. This volume, pp. 125–132.

Walls, G. 1997. Status of loranthaceous mistletoes in the Hawke's Bay Conservancy. This volume, pp. 51–53.

Wilcox, M. 1984. Mistletoes in the Rotorua Lakes District. *Rotorua Botanical Society Newsletter* 3, 5.

Discussion of Threats to Mistletoes*

Facilitated by **David Norton**
Transcribed by **Suzanne Clegg**

The following notes have been taken directly from the taped discussion at the meeting and have only been edited for clarity.

DN: Two issues to consider: Threats on a national vs. regional basis, and species vs. ecosystem basis.

Two questions to consider: Are possums a threat to mistletoes, and what are other threats? (direct or indirect threats).

Hypothesis: Possums are important but impact depends on:
– history of possum colonisation
– nature of the ecosystem/other foods available
– other herbivores present
– biology of the mistletoe itself

⇒ possums are not universally important but **are** a threat.

Points made in discussion:

- We don't know that where possums don't seem important now, they might in future (CO).
- Possums may affect hosts so that they are more susceptible to mistletoes (LF).
- We don't know if there has been a decline because there's no historical evidence of mistletoe distribution/abundance (AB).
- You can spend funds on monitoring or possum control (trade-off). Managers need to accept need to manage possums, they're definitely a threat (GL). Still need to monitor possum control (NR). Difficult when you have a large forest cf. fragments (GL).

DN: Conclude that possums are important but the impact is not always direct.

Discussion on ecosystem health and variable impact of possums on different ecosystems and mistletoes as indicator species of ecosystem health.
⇒Cannot use mistletoes as direct indicators, depends on other foods available.

- Dry eastern beech forests have very low palatable biomass, supported possums for >50 years, yet mistletoes persisted and can be locally common.
- Beech largely ignored in diet work.

Discussion on role of deer in combination with possums.

⇒Deer are part of the process but not a direct threat to possums.

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* Contributors: AB, Amanda Baird; CJ, Cathy Jones; CO, Colin Ogle; CW, Carol West; DK, Dave King; DN, David Norton; FO, Fred Overmars; GL, Graeme Loh; GW, Geoff Walls; JB, John Barkla; JR, Jason Roxburgh; JS, John Sawyer; LF, Lisa Forester; NR, Nick Reid; PdL, Peter de Lange; SCo, Shannel Courtney; SC, Suzanne Clegg; ??, unknown.

Question raised: why are mistletoes so common at Craigieburn?

- They **are** common in places, but there are huge areas where they're not (GL).
- *Alepis* (the most common at Craigieburn), disappeared first in North Island (attributed to possum browse).

⇒immediate contradiction (DN).

- Suggest that mistletoes at Craigieburn are sufficient to maintain possums. Maybe there are enough birds to spread mistletoe seed fast enough (DN).
- Clear we don't understand the process, maybe never will, so let's treat it in ignorance, knowing possums will have some effect (GL).
- Soil fertility/nutrient uptake – may have a role, e.g., Tongariro/Taupo (PdL).
- -Example of mimicry in Australian mistletoes and connection with nutrient levels. Don't agree this occurs in NZ. But, possums **do** select for nutrients (DN) or absence of toxin (NR).

Discussion on evidence for/against removal of possums.
e.g., Waitutu – two sides of the river, one with possums, one without.
Rowallan – high mistletoes, high possums. ⇒ anomalies.

- opportunity for research in deer-free areas of Fiordland (CW).

Discussion on how to get funds for possum control based on mistletoes present.

- Craigieburn **not** typical. If an area only has mistletoes and we say mistletoes are not vulnerable to possums, we'll never have a case over a huge forest area, especially if we've done no monitoring (AB).
- But it's a regional vs national issue (PdL). But we never rate beech (AB).
- Misunderstanding in HO – need more emphasis on representativeness (DN).
- Need to develop standard monitoring so we can make comparisons at a national and regional level (PdL).
- What about possums as predators of birds' nests? Very few birds in some areas ⇒ indirect effect (??). Potential association of mohua and mistletoes – implies mohua may have been an important fruit disperser (DN) (see Colin O'Donnell's work – vectors for *P. colensoi*).

DN – Let's list **other** threats to mistletoes:

- Loss of birds (as pollinators/dispersers) (DN).
- Overcollecting (PdL).
- Natural mortality (GL) e.g., catastrophic stochastic event. e.g., highly fragmented beech forest – normal dieback could wipe it out. (counter-argument that isolated trees/ mistletoes do well ⇒ not an issue). (Although they may be a communal meeting place for birds.)
- Goats/cattle could wipe out *Ileostylus*.
- Invertebrate/fungal pathogens (we know little).
- Vandalism, e.g., *Trilepidea*, Benge Park.
- Habitat quality.
- Nutrient levels.

GL – What is Brian Molloy's view on possums' impact?

PdL – Molloy accepts possums are a factor but not sole factor. Decline is directly attributable to loss of other favourite food plants, e.g., mistletoes on a tree in a paddock are untouched because possums prefer grass.

⇒Impact is complex. We are looking at an ecosystem under threat (DN, PdL), possums are a major problem but we need to change our focus to the ecosystem.

JS – At a species level it would be useful to present a list of ecological requirements for each species – then we could manage the different threats at different parts of the life cycle, rather than just focussing on possums. (DN listed factors which determine whether or not a mistletoes will grow).

Discussion on host specificity. No evidence in NZ of hosts developing resistance to mistletoes. Why then, do we see a patchy distribution? (CW) Could be to do with pollination/dispersal vectors – there could be a symbiosis, e.g., mimicry.

GL – We're getting bogged down, trying to solve the problem.

Final word on threats: ...

- Should treat large forests differently to fragmented habitat (AB).
- But that separation is more to do with where different species grow e.g., *Ileostylus*: lowland sp., more fragmented lowland habitat ⇒ different situation to "beech" mistletoes (PdL).
- The North Island situation reminds me of the cabbage trees – threats become extreme because of ecosystem degradation (AB).

Part 4 Current status and management solutions

Conservation status of New Zealand loranthaceous mistletoes: a comment on the application of IUCN Threatened Plant Committee Red Data Book categories

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SUMMARY

New Zealand's loranthaceous mistletoes are undergoing a national decline in abundance. Over the last decade this has prompted calls for their national listing as threatened species, which was finally achieved in 1993. In this paper we argue that this listing (and subsequent ones), based as it is on the IUCN Red Data book categories, is erroneous. While we acknowledge that loranthaceous mistletoes are undergoing a national decline, their shear abundance — in terms of numbers of individuals — means that they cannot possibly be as threatened as their present IUCN classifications would imply. Using other examples from our indigenous flora and fauna we argue that the IUCN system is deficient, and that mistletoes are just one of a much larger group of biota whose decline is a warning of degradation within the ecosystems they occupy. If we are to continue using the present IUCN Red Data Book categories we would prefer to see our loranthaceous mistletoes removed from the national threatened plant list. However, we support the recent suggestion that New Zealand has no need of the IUCN system and would be better to devise its own system of threatened species classification. If this was done, then nationally the management of declining species such as mistletoes could be more adequately catered for.

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de Lange, P.J., Norton, D.A., Molloy, B.P.J. Conservation status of New Zealand loranthaceous mistletoes: a comment on the application of IUCN Threatened Plant Committee Red Data Book categories. Pp. 171–177 *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.

1. INTRODUCTION

In the latest revision of the New Zealand Botanical Society threatened and local plant lists (Cameron *et al*. 1995), all seven loranthaceous mistletoes recorded from New Zealand have been listed either as threatened or local, including two species presumed extinct. In addition, *Korthalsella salicornioides*, which belongs to the Viscaceae (Barlow 1964), is listed as Insufficiently Known. Aside from the two presumed extinct species, *Muellerina celastroides* and *Trilepidea adamsii*, these listings are based on submissions received by the New Zealand Threatened Plants Committee which document an apparent decline of the endemic beech mistletoes *Alepis flavida, Peraxilla colensoi, P. tetrapetala,* and large-leafy mistletoe *Tupeia antarctica*, and the indigenous large-leafy mistletoe *Ileostylus micranthus*.

While we accept that some of these mistletoes are now uncommon in parts of their former range, especially in the North Island, they are, nevertheless, still abundant in parts of the South Island. Therefore we consider the present conservation rankings of our loranthaceous flora in the New Zealand Threatened and Local Plant Lists (see Cameron *et al*. 1995) as inappropriate. In so saying, we recognise these rankings have arisen through the New Zealand Threatened Plants Committee's adherence to those categories adopted by the Threatened Plants Committee of the IUCN (Given 1981) as was prescribed by the New Zealand Botanical Society through their adoption of resolution iv (de Lange & Taylor 1991:17). We wish to make it perfectly clear that we are not criticising the functioning of the committee, rather, we are unhappy with the tools they have been requested to use. This is because the IUCN categories used by the committee have *no sound scientific basis* (Mace & Lande 1991), with the decision to categorise taxa primarily based on *subjective opinion*. Therefore despite their wide international usage, the IUCN categories are far from perfect, and remain a *source of constant dissatisfaction* (see for example Leigh *et al*. 1981; Mace *et al*. 1993; Harris 1994).

As a result of these problems, the IUCN system has recently been revised (IUCN 1994) and a number of new categories proposed, namely: Critically Endangered, Lower Risk (Conservation Dependant, Near Threatened, Least Concern), and Data Deficient. To assess which of these categories most applies to a candidate taxon, a series of detailed critieria have been prepared for each category. While the new system has a number of advantages and is certainly more quantifiable, we believe it is still unsatisfactory. In particular, we note the new system's failure to adequately distinguish between naturally uncommon and genuinely threatened taxa, while the criteria used to define each category does not work readily with many New Zealand examples. Lastly, widespread and locally common plant taxa known to be undergoing a national decline are not adequately catered for (de Lange & Norton, unpubl. data). With respect to the New Zealand situation, we therefore advocate that until a more relevant system is developed for the ranking of potentially threatened plants, the new IUCN threatened species categories should either be used in a more **conservative** manner, and modified to fit New Zealand examples, or an alternative system devised.

In this paper we argue this view by considering the evidence for the present conservation rankings given to our loranthaceous mistletoes. We then compare these with other similarly classified taxa and with those not presently ranked but which are recognised as undergoing a national decline.

2. MISTLETOES AS NATIONALLY VULNERABLE SPECIES — A COMMENT ON THE EVIDENCE

It is our opinion that the reputed decline of mistletoes in some areas of New Zealand (see examples cited by Ogle and Wilson 1985, Ogle 1997) currently lacks an objective, comparative historical basis (de Lange *et al*. 1997). That there is anecdotal evidence for the decline of mistletoes from parts of the country we do not deny, but we believe this decline has been over-stated (cf. Ladley & Kelly 1995), and is itself contradicted by the fact that mistletoes remain abundant in other locations where the attributed agents of decline (see Ogle & Wilson 1985) are also present. Indeed, recent surveys have even relocated mistletoes in areas where they had previously been considered locally extinct (e.g., *Peraxilla tetrapetala* at the Chateau, Tongariro National Park, de Lange 1987 cf. Ogle & Wilson 1985, and in the Tararua Range, (J.W. Sawyer, pers. comm. 1994), or discovered them in areas where they were previously unrecorded (e.g., *Peraxilla tetrapetala* near Waipoua Forest, Northland, AK 212173!). Furthermore, both *Peraxilla* species and *Alepis flavida* are very common in the mountains of the central and southern South Island (de Lange *et al*. 1997), while *Tupeia* and *Ileostylus* are locally abundant on both indigenous and naturalised host species throughout New Zealand. In fact, these latter two have even extended their range into urban situations e.g., Whangarei, Rotorua, Nelson, Akaroa and Dunedin (de Lange *et al*. 1997). Finally, research which shows that possums (*Trichosurus vulpecula*) targeted mistletoes in the Nelson region (Wilson 1984) is offset by recent studies from the Haast area which demonstrated that such herbivory is part of a complex pattern of browsing regimes which has minimal impact on the abundance of mistletoes within that study area (Owen & Norton 1995). Clearly then, there is room for further study before the exact role possums play in mistletoe decline is resolved (Norton 1997).

On-going research by the authors suggests that mistletoes were never as “common” in the North Island and Westland to the extent that they were in other parts of the South Island (de Lange, Norton & Molloy, unpubl. data.). This is due largely to a combination of the following factors:

1. The relative distributions of their **principal** hosts (e.g., silver beech, *Nothofagus menziesii*, and mountain beech, *Nothofagus solandri* var. *cliffortioides*, for the beech mistletoes *Alepis* and *Peraxilla*).
2. Widespread forest disturbance in the South Island over the last 1000 years giving rise to numerous remnants, with the resultant increase in forest margins, thereby enhancing the conditions needed for the proliferation of mistletoes (B.P.J. Molloy, unpubl. data).
3. As a result of forest disturbance there has been exposure of largely mature beech trees. These act as suitable perching sites for birds (the main dispersal vector for mistletoes) and provide optimum sites suited to the mode of growth and attachment structures of the “beech mistletoes”.

We recognise that various factors, separately or in combination, can threaten the survival of loranthaceous mistletoes. These include habitat loss (especially the loss of principal host species), herbivory, and loss of pollinators and dispersers. Undoubtedly, these factors have been important historically (Wilson 1984, Ogle & Wilson 1985, Norton 1991) and will almost certainly continue to operate in the future (Jones 1993, Ladley & Kelly 1995a,b), especially near the geographic limits of the various mistletoes and/or their principal hosts. However, while we accept that these factors are significant, we consider them as symptoms of the overall degradation of the ecosystems that these species occupy, and note that similar factors are also causing declines in many other widespread plant and animal taxa not presently considered threatened (see below). Furthermore, we would also suggest that the importance of some of these factors has been over-stated. For example, the suggestion that mistletoes may be threatened through a loss of pollinators (Ladley & Kelly 1995a,b) is not as clear cut as has been suggested. Research conducted by one of us (BPJM) into the reproductive biology of our loranthaceous mistletoes during the 1970s discovered that while indigenous birds can assist pollination in both *Peraxilla* spp., all the extant loranthaceous species, except *Tupeia* and unisexual plants of *Ileostylus* (which are insect-pollinated), are capable of self-pollination and self-fertilisation (cf. Ladley & Kelly 1995a,b). It is also clear that the role of introduced birds as dispersers, especially for *Tupeia* and *Ileostylus*, has been seriously under-estimated.

Therefore we find ourselves asking this key question, “is the observed decline of mistletoes sufficient in parts of New Zealand to warrant their being ranked as **nationally threatened**?”.

3. MISTLETOES AS NATIONALLY VULNERABLE SPECIES — THE CONTRADICTIONS

Both *Peraxilla* species and *Alepis flavida* are currently ranked Vulnerable (Cameron *et al*. 1995). Other Vulnerable species include *Carmichaelia curta* (confined to the Waitaki River valley where it occurs largely in precarious sites along roadsides, because its former habitat is now dominated by pasture grasses; P. Heenan, pers. comm 1995), *Hebe acutiflora* (confined to two river catchments in Northland where it is under direct threat from competition by mistflower *Ageratina riparia* (E.K. Cameron, DSIR Site Report 2/94 and Cameron, 1990), *Hebe speciosa* (formerly present in at least 15 locations along the western coast of North Island and northern South Island, and now confined to 5 sites but only “common” at two; de Lange & Cameron 1992). By comparison, the above three mistletoes occur at a large number of sites, with many thousands of individuals, and do not show anywhere near the decline exhibited by these other Vulnerable taxa.

In fact, both *Alepis* and *Peraxilla tetrapetala* have extended their distribution and increased their density locally along the forested edges of State highways, ski roads, and other tracks cut through continuous beech forest in the South Island at various times over the last 60 years or so (Molloy, unpubl. data). Similarly, *Peraxilla colensoi* has done precisely the same in disturbed forest, but mainly where silver beech has had a long-standing presence.

Tupeia antarctica is presently ranked as a Rare species (Cameron *et al*. 1995), a listing which positions it alongside several taxa such as *Pittosporum turneri* and *Pittosporum obcordatum*. These *Pittosporum* species are considerably less abundant and do genuinely appear to be under a moderate level of threat throughout their range (Ecroyd 1993, Clarkson & Clarkson 1994). *Tupeia*, on the other hand, remains an abundant species throughout its primarily eastern distribution in New Zealand, especially in the South Island (de Lange *et al*. 1996).

Similarly, the ranking of *Ileostylus* as Local is also questionable. Unlike many other species listed as Local, *Ileostylus* is a very common species throughout much of New Zealand (de Lange *et al*. 1996). However, as the category Local is not one of the IUCN threatened plant committee categories, it will not be discussed further here.

4. CONSERVATION STATUS OF NEW ZEALAND LORANTHACEOUS MISTLETOES

In terms of their conservation status, we believe that the loranthaceous mistletoes are in a somewhat similar position to a number of other New Zealand plants such as cabbage tree (*Cordyline australis*), kohekohe (*Dysoxylum spectabile*), pohutukawa (*Metrosideros excelsus*) and northern rata (*Metrosideros robusta*), and for that matter birds such as kereru (*Hemiphaga novaezeelandiae*) and the New Zealand black-browed mollymawk (*Diomedea melanophrys impavida*). None of these species are considered threatened nationally, yet all have shown pronounced decline in some parts of New Zealand for various reasons and will decline further if the same threat factors continue to operate. If we consider cabbage tree, for example, we note that Beever *et al*. (1991) examined the evidence for ranking this species as Vulnerable, concluding that while cabbage tree was a "**vulnerable**" feature of the North Island landscape it was premature to consider it a Vulnerable species "*in the IUCN Red Data Book sense as the wild population was still very large*". We accept this and believe that the same view is applicable to the extant New Zealand members of the Loranthaceae, whether they are classified as Vulnerable or Rare.

These examples suggest that a simple linear classification, such as the IUCN categories used in the national threatened plant list, is not suitable for dealing with species that are declining in parts of their range where they may be locally uncommon, but are common to abundant elsewhere.

It is also extremely unlikely that our extant loranthaceous mistletoes are threatened nationally within the time-spans envisaged by IUCN categories "Vulnerable" or "Rare" (see Mace & Lande 1991 for further discussion on time-scales). Furthermore, other species classified as Vulnerable or Rare are in much greater danger of extinction nationally than the mistletoes (see examples above). The stance we have taken on this issue does not deny the problems these species are facing in some parts of the country, but it is a realistic one when we consider the present status of mistletoes nationwide. To rectify this problem we suggest that alternative categories should be devised to deal with species such as mistletoes, pohutukawa, kohekohe and cabbage tree that recognises that they are declining in parts of their range, but are not threatened with extinction nationally. It may even be timely to move beyond the present preoccupation with "international" schemes such as those developed by the IUCN and modify our threatened plant ranking systems to take into account the real nature of rarity within the New Zealand flora. In saying this we are not necessarily advocating abandoning international classification schemes altogether, but believe that the many unique features of the New Zealand flora and environment warrant adopting an indigenous perspective in classifying rarity (cf. de Lange & Norton, unpubl. data).

5. ACKNOWLEDGEMENTS

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6. REFERENCES

Barlow, B.A. 1964. Classification of the Loranthaceae and viscaceae. *Proceedings of the Linnaean Society of New South Wales* 89, 268–272.

Beever, R.E., Rees-George, J., Robertson, G.I., Hawthorne, B.T., Beresford, R.E. 1991. Cabbage tree: a threatened species? *New Zealand Botanical Society Newsletter* 26, 21.

Cameron, E.K. 1990. The next generation of problem plants. New Zealand Institute of Noxious Plants Officers Conference Proceedings, 41–19.

Cameron, E.K., de Lange, P.J., Given, D.R., Johnson, P.N., Ogle, C.C. 1995. New Zealand botanical society threatened and local plant lists (1995 Revision). *New Zealand Botanical Society Newsletter* 39, 15–28.

Clarkson, B.D., Clarkson, B.R. 1994. Ecology of an elusive endemic shrub, *Pittosporum obcordatum* Raoul. *New Zealand Journal of Botany* 32, 155–168.

de Lange, P.J. 1987. A fading flower – the park's mistletoe. *Tongariro* 28, 8–11.

de Lange, P.J., Taylor, G.A. 1991. Threatened plant symposium. *New Zealand Botanical Society Newsletter* 25, 17–19.

de Lange, P.J., Cameron, E.K. 1992. Conservation status of titirangi (*Hebe speciosa*). *New Zealand Botanical Society Newsletter* 29, 11–15.

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

Ecroyd, C.E. 1993. Regeneration of *Pittosporum turneri* communities. NZFRI Contract Report, Investigation No. TT3.

Given, D.R. 1981. Rare and endangered plants of New Zealand. Reed, Wellington

Harris, S. (ed.) 1994. Native Higher Plant Taxa which are Rare or Threatened in Tasmania. Flora Advisory Committee, Species at Risk Series, Parks and Wildlife Service, Hobart, Tasmania.

Jones, C. 1993. Protection measures for mistletoes in Tongariro-Taupo Conservancy. *Ecological Management* 1, 1–3.

Ladley, J., Kelly, D. 1995a. Mistletoes: Showy specialists at risk? *Forest & Bird* 278, 16–21.

Ladley, J., Kelly, D. 1995b. Explosive New Zealand mistletoes. *Nature* 378, 766.

Leigh, J., Briggs, J., Hartley, W. 1981. Rare or Threatened Australian Plants. *Australian National Parks and Wildlife Service Special Publication 7*. Australia.

Mace, G., Collar, N., Cooke, J., Gaston, K., Ginsberg, J., Leeder-Williams, N., Maunder, M., Milner-Gulland, E.J. 1993. The development of new criteria for listing species on the IUCN red list. *Species* 19, 16–22.

Mace, G.M., Lande, R. 1991. Assessing extinction threats: towards a reevaluation of IUCN threatened species categories. *Conservation Biology* 5, 148–157.

Norton, D.A. 1991. *Trilepidea adamsii:* an obituary for species. *Conservation Biology* 5, 52–57.

Norton, D.A. 1997. An assessment of possum (*Trichosurus vulpecula*) impacts on loranthaceous mistletoes. This volume, pp. 149–154.

Ogle, C.C. Evidence for the impacts of possums on mistletoes. This volume, pp. 141–147.

Ogle, C.C., Wilson, P.R. 1987. Where have all the mistletoes gone? *Forest & Bird* 237(3), 10–13.

Owen, H.J., Norton, D.A. 1995. The diet of introduced brushtail possum *Trichosurus vulpecula* in a low-diversity New Zealand *Nothofagus* forest and possible implications for conservation management. *Biological Conservation* 71, 339–345.

Wilson, P.R. 1984. The effects of possums on mistletoe on Mt Misery, Nelson Lakes National Park. Proceedings of section A4E, 15th Pacific Science Congress, Dunedin, February 1983 (P.R. Dingwall, compiler). Department of Lands and Survey, Wellington.

Discussion on status of mistletoes*

Facilitated by **Carol West**
Transcribed by **Suzanne Clegg**

The following notes have been taken directly from the taped discussion at the meeting and have only been edited for clarity.

PdL/DN publishing new classification system. Can't change status of taxa until there is a revision, but this doesn't mean we can't act independently and make our own decisions, based on new information.

- Changing the Threatened Plant Committees ranking won't be easy.
- But we're changing already, using "LOCAL", not an IUCN category.
- There are a number of species (cabbage tree, pohutukawa, kereru etc.) which are not vulnerable in an IUCN sense, but are part of a vulnerable landscape. Mistletoes fit into this category, at the least.
- It is important to distinguish between species which are declining and those which are naturally uncommon.

Discussion on Molloy & Davis. Severe problems, not consistent between birds and plants. Also biased because the plants which go into Molloy & Davis come from the Threatened Plant Committee list (i.e., subject to IUCN system). Others are missing and some shouldn't be there (DN, PdL).

GL – I'm here to talk about mistletoes, not invent a new ranking system. We just need to state in plain English what the status is so we can justify where to spend the possum control funds. Our senior managers need something monosyllabic.

Discussion on how we would go about describing the status. Need to know:
- List of requirements for mistletoes (pollination, dispersal).
- Threats.
- What would happen if we do nothing (mucked around with matrix of threats, status, scores – scrapped).

Concern as to how managers interpret a statement on status.
- Conservancies with a stronghold of plants tend to ignore it and work on species in more trouble. Need a watertight statement (PdL).
- Already been told I'm doing too much on non-threatened species (CJ).
- The PSP/EPP review will help because we can push the case for mistletoes more easily from an ecosystem perspective.

Started discussing strategy (GL gave a list) – see later discussion (chapter 8).

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Part 5 Current management

Mistletoe management, Tongariro-Taupo Conservancy

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SUMMARY

Five species of leafy loranthaceous mistletoes have been recorded recently (1990–1996) from the Tongariro-Taupo Conservancy of the Department of Conservation. These are *Alepis flavida*, *Ileostylus micranthus*, *Peraxilla colensoi*, *P. tetrapetala* and *Tupeia antarctica*. Survey and management techniques for these five species are reviewed.

1. INTRODUCTION

In general, we have concentrated our survey, management and monitoring efforts to date on plants growing near tracks, generally using old herbarium records or hearsay as the basis for commencing survey. This is obviously cost-effective when it comes to time and effort required to both locate plants originally and re-find them when necessary for management. It also means that we can capitalise on the advocacy opportunities which arise when members of the public see that work is being done on a species.

All five extant species of leafy mistletoes are present in the conservancy (Jones 1997) and all except *Ileostylus micranthus* are severely browsed by possums if no protective measures are taken.

For all species, each host found is tagged and each mistletoe plant is recorded on monitoring sheets which detail host species, dbh, host health, dimensions of plant, height up the host trunk and aspect, degree of browse, whether flowers or seeds are present and any other comment that seems relevant. Documentation of the location of the plants is important, as they can be very difficult to re-find, particularly if different personnel are involved. One field centre has put all this information into a Microsoft Excel spreadsheet so that the data can be manipulated and so that it is easy to compare records from year to year. The system is still in need of polishing to make it ideal. Selected plants are photographed each year. Photographs should be of the same plants each time and taken from the same angle to allow for comparisons. It is possible then to use photography to monitor a sample of the population for gross change each year, and only undertake the more detailed measuring, and checking of collar tightness and efficiency, every three or four years on a cyclical basis. It is desirable to monitor the plants at either flowering or fruiting time and, of course, always at the same time each year.

Jones, C. Mistletoe management, Tongariro-Taupo Conservancy. Pp. 183–186 *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.

Collaring is done following the method described in Jones (1993), although we have found that it is easier to make the rivet holes with a drill. Hosts are usually only collared if they can be isolated from neighbouring trees, though it may be possible to collar above and below the mistletoe and avoid the need for canopy isolation. A little judicious pruning is necessary, or collaring the tree next door may help. It is necessary to leave a little slack in the collar as trees grow in diameter, and to check them about every three years to ensure that the collar is not getting tight. If the collars are cut with some overlap and fastened with rivets it is possible to re-use them.

We have not yet managed to transfer mistletoes to new hosts by seed transfer or grafting, although it has been done elsewhere in the past. Masters students are working on this aspect of propagation as well as grafting.

2. SURVEY AND MANAGEMENT FOR INDIVIDUAL SPECIES

Alepis flavida

This species is relatively easily visible because of the reddish tint to the leaves and because they grow out towards the ends of the branches. Mountain beech at this altitude is quite stunted as well. Survey, therefore, is just a matter of careful observation.

Old records of *A. flavida* growing on red beech at Lake Rotopounamu have been followed up without success. These plants would be harder to find because the host trees are tall and often have red colouration in their leaves.

Because of the manner of growth of this mistletoe species and the stunted nature of the hosts in the area, collaring was not possible on all hosts on the Round-the-Mountain Track. Some of the plants have been caged with chicken netting instead. This unfortunately keeps out pollinators and dispersers as well as browsers. *Alepis* does appear to self-pollinate, but as part of further management, the netting could be removed at appropriate times to allow dispersal of fruit.

Peraxilla colensoi

Because most of these are very high up in the host trees, we found that the best method of survey was to use binoculars while walking with the sun behind us so that the mistletoe leaves shone in the sunlight. Hazards associated with this are sore necks and the possibility of confusion with *Griselinia littoralis*. The mistletoes are a slightly greyer green once you get your eye in. (We created another hazard by measuring our whereabouts from the western end of the road and working in the morning!, i.e., we had to walk backwards.) Prior to collaring it was common to find leaves on the ground that had large bites taken out of them, presumably by possums. Very few of the Kaimanawa population appear healthy in spite of our efforts at collaring, and several plants seem to be dead. So far, because of the difficulties in reaching the plants, it has been impossible to examine them in detail and ascertain whether ill-health is due to possums getting past the collaring system or some other factor. 1080 possum control is not possible here because the area is a designated Recreational Hunting Area. The Ohakune population are collared and the larger plants flower well.

Peraxilla tetrapetala

Most of the hosts of this species are small enough to make it relatively easy to find the plants. They are generally close to the trunk of the host tree and easily distinguished because their leaves are larger and shinier than the host leaves. In some places the survey was extended beyond the immediate track edge by setting up a 100 x 50 m grid with tapes. A high percentage of host trees of this mistletoe have been collared, and trapping and poison efforts have concentrated on the areas where they grow. A few plants growing low on hosts have been caged with chicken wire.

Tupeia antarctica

Again we concentrated our survey efforts along tracks and the lakeshore. The plants are very easy to see as they sprout straight from trunks and branches. The leaves are generally a paler green than the host tree leaves. In many instances plants were browsed right back to the bark of the host, but surveyors quickly became adept at spotting the warty lumps which indicate the presence of mistletoe tissue. Collaring, sometimes above and below the mistletoe, has allowed many plants to recover. Because there seems to be little natural regeneration of *Pittosporum tenuifolium*, the main host species, in the area, we have planted new trees in the hope that they will become infected with mistletoe. We are looking at setting up a planting cycle to ensure that there are always fresh hosts available. Local residents have shown great enthusiasm for this project, helping with possum control and notifying us of plants on their land which we collar.

Ileostylus micranthus

Apart from Masters students doing observations, no management is being carried out on this species.

3. SUMMARY OF MANAGEMENT PROGRAMME

The following notes summarise the approach we are taking to mistletoe management in the Tongariro-Taupo Conservancy:

1. Survey Old records (herbarium, hearsay)
   Tracksides
   – tag
   – record details
2. Manage Collar-cage
   Possum control
   Plant new hosts
   Transfer seed/graft?
3. Monitor Record again (3 yr cycle)
   Photograph sample of population (every year)
   Check collar tightness and isolation of host from neighbours
4. Alter management regime if necessary

4. REFERENCES

Jones, C. 1993. Protection measures for mistletoes in Tongariro-Taupo Conservancy. *Ecological Management* 1, 1–3.

Jones, C. 1997. Status of loranthaceous mistletoes in the Tongariro-Taupo Conservancy. This volume, pp. 39–41.

Mistletoe protection and monitoring strategies on the West Coast

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SUMMARY

Possum colonisation appears to be the major factor in the decline of leafy loranthaceous mistletoes on the West Coast. Mistletoe populations in Buller and north Westland are now largely small remnants, but they are still extensive in south Westland where possums are only now establishing. Mistletoe protection programmes in Buller and north Westland centre on banding individual plant hosts. In south Westland, there are extensive ecosystem directed possum control operations. A mistletoe monitoring programme was established in the Moeraki possum control area in 1990–91. Initial results show declines in mistletoe condition despite possum control. Control of possum populations to low or zero density is likely to be necessary, although perhaps not sufficient, to ensure long-term survival of the extensive mistletoe populations of south Westland.

1. MISTLETOE DISTRIBUTION AND POSSUM COLONISATION ON THE WEST COAST

The major declines in the distribution of leafy mistletoes (*Peraxilla colensoi, P. tetrapetala*, *Alepis flavida*) evident on the West Coast since the early 1900s appear to be related primarily to the pattern of colonisation by the Australian brushtail possum (*Trichosurus vulpecula*). By 1950, possums had colonised the major valleys and lowlands of the West Coast as far south as Paringa, and by 1980 had covered the remaining higher land in Northwest Nelson, the Victoria Range and Maruia Valley, and the western flanks of the Southern Alps (Pracy 1980, Fig. 1). In 1980, southern South Westland was one of two large forested areas in New Zealand still largely possum free (the other being Fiordland and Waitutu forest). By 1990, possums had colonised its major valleys (Rose *et al*. 1993, Fig. 2). In the five years since 1990, with some unwelcome help, they have substantially invaded the Cascade region (Richard Nichol, pers. comm.).

The longer period of possum colonisation in Buller and North Westland appears to be the main difference between the largely remnant status of leafy mistletoes there, and the survival of extensive populations in southern South Westland.

Overmars, F. Mistletoe protection and monitoring strategies on the West Coast. Pp. 187–191 *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 process of mistletoe decline may be akin to the sequential local extinction of palatable plant species in forest in the Orongorongo Valley (Brockie 1992); although recent work by Owen & Norton (1995) in a recently colonised forest in the Haast valley suggests mistletoes are only heavily grazed when alternative foods are unavailable. The Department of Conservation's mistletoe management has therefore been directed towards locating and protecting remnant populations in Buller and North Westland, and to large scale possum control operations to protect overall ecosystem quality (including mistletoe populations) in southern South Westland.

2. LOCALISED MISTLETOE PROGRAMMES IN BULLER AND NORTH WESTLAND

Mistletoe populations have been located in the course of other field work, checking herbarium records (CHR only at this stage), specific surveys in North Westland (Van Uden & Lamoureaux 1994a, Overmars & Buckman 1995; unpublished DoC reports, Hokitika), and using information from members of the public. Programmes to band the hosts of selected mistletoes and to monitor the fate of protected and unprotected individual mistletoes in the Upper Maruia have been planned and implementation commenced in the 1995–96 summer. The intention is to retain the species throughout their distributional range, and to retain population nuclei for possible future re-colonisation.

3. SUSTAINED POSSUM CONTROL PROGRAMMES IN SOUTH WESTLAND

The Department of Conservation on the West Coast has taken advantage of the greatly increased funds made available since 1990 to undertake major sustained possum control programmes aimed at protecting or restoring intact functioning ecosystems. The programmes are usually targeted at protecting one or more specific vulnerable ecosystem components (e.g., fuchsia, southern rata, kaka, kiwi, mistletoe). They involve an initial knockdown of possum population density to low levels (more than 80% where possums are established), and subsequent maintenance control to keep them at that level. Any goat populations are also controlled, or eradicated where possible, and control of other mammalian herbivores and predators is now being investigated. From this focus of controlling pests in the one area has evolved the concept of mainland habitat island programmes on the West Coast (Norton 1993).

The possum programmes started in 1990 in four areas: Paparoa lowland karst forests, Otira-Deception and Copland valley rata-kamahi forests, and Moeraki silver beech forests (James 1990, unpublished DoC report, Hokitika). The total possum control programme on the West Coast now costs *c*.$1 million per annum, and will eventually cover 320 000 ha (Terry Farrell, pers. comm.).

In South Westland, these programmes have been extended from the initial Moeraki area to a full sequence stretching from the Landsborough River down the Haast Valley and across the Okuru and Turnbull valleys and western Southern Alps to the Waiatoto River. Major extensions are planned in the next two years to encompass the Cascade region (from Jackson Bay/Arawhata river to the Southland conservancy boundary), the Haast Range-Burmeister, and the north bank of the Haast valley from the Clarke to the Tasman Sea. The South Westland programmes cover *c*.220 000 ha, and are an attempt to maintain ecosystems which have not yet been ravaged by possums until some future biological control is available. Mistletoes, especially the two *Peraxilla* species, are a prominent component of these ecosystems. These areas are all in the Southwest New Zealand World Heritage Area, and subject to a request from the NZ Conservation Authority to investigate potential national park status.

4. MOERAKI MISTLETOE MONITORING

The outstanding conservation values of the Moeraki area, one of four areas initially selected for sustained possum control on the West Coast, include kaka, yellowheads and extensive mistletoe populations (*Peraxilla colensoi, P. tetrapetala)* in predominantly silver beech and mixed beech-podocarp forest (James 1990, unpublished DoC report, Hokitika). The original *c*.7600 ha area, centred on the upper Moeraki valley and the Windbag (east of SH6/Alpine Fault), has since been extended to the full *c*.20 000 hectares between the Moeraki and Paringa rivers, from the Southern Alps to the sea. Forests with a substantial southern rata component are now included. Possum numbers were generally low and localised in 1988 (Farrell & Mead 1989, unpublished DoC report, Hokitika), and were reduced further by ground hunting in 1991, 1993–94 and 1994–95 using both traps and cyanide (Terry Farrell, pers. comm.).

An essential requirement of sustained possum control programmes is monitoring to ensure that the identified conservation values are being successfully protected. A mistletoe condition monitoring programme was established for Moeraki-Paringa in 1990–91, and was first re-measured in 1993–4. Its aim is to monitor the condition of a fixed sample of mistletoe on a long-term basis, and how that relates to possum densities as they fluctuate in response to sustained control (Buglass 1991, unpublished DoC report, Hokitika). Monitoring programmes which include mistletoe condition were also established in 1993–4 in three other South Westland possum control areas, the Haast, Landsborough and Okuru-Turnbull Valleys (Van Uden & Lamoureaux 1994b, 1994c, unpublished DoC reports, Hokitika; Jo Crofton, pers. comm.), but insufficient time (three years) has elapsed to undertake re-measurement.

Six permanent transect lines were initially established in the Moeraki area. Two more were added in 1991–92, and a further two in 1993–94. Most run on fixed bearings from valley floor to the upper altitudinal limit of mistletoes (usually subalpine). Four are located in the upper Moeraki, two are in the Windbag, and the additional pairs are in the Paringa valley and the Moeraki valley west of the Alpine Fault. The extra two lines in the Paringa, in an area of substantially higher possum densities, were added as a means of measuring the benefits of possum control to restore conservation values. The two lines in the Moeraki valley west of the Alpine Fault, at Boulder and Kaka Creeks, are in the extended possum control area.

The lines were established at flowering time (December) and marked by orange permolat. A numbered plot was established at each site where mistletoes were seen within 25 m of a line, and the nearest tree on the line marked with orange permolat. The host tree of each mistletoe located within 25 m of this plot tree was then marked with permolat (different colour) and tagged with numbered metal tags. The intention of marking and tagging host trees is to ensure the same mistletoe populations are re-assessed on subsequent surveys, to reduce the observer bias that would occur in line re-measurement.

Mistletoe condition is assessed on a four point scale and recorded on survey cards (Table 1): D = Dead; 1 = Moderate to extreme defoliation (67–99%); 2 = Low to moderate defoliation (34–66%); 3 = Nil to low defoliation (0–33%). During the initial setting up of the study no dead mistletoes were tagged or recorded. This was to allow for a full complement of living plants in the first sample. Over time, some of the study plants will die (hence the dead category). Defoliation is assessed visually with the aid of binoculars. Scoring is usually done by more than one observer on a consensus basis. Also recorded on the survey card are the tag number, altitude, aspect, distance and compass bearing from the plot marker on the survey line.

Possum densities are assessed by "trap-catch" lines adjacent to the mistletoe lines. These are also permanently marked with permolat, consist of 50 marked trap sites, and usually run from valley floor to the upper altitude limit of mistletoes. They are set for 3 consecutive fine nights, giving a total of 150 trap nights for each line. A standard lure ("West Coast special") and trap type (Victor No. 1) are used. The number of animals caught, sex, colour, age, weight and general condition are recorded, along with any non-target species.

Mistletoe condition and possum density results to date are shown in Table 1.

The data show a clear decrease in mistletoe foliage in the Moeraki over the three year monitoring period. A number of factors may be at play: loss of host trees and death of elderly plants, time lag in mistletoe response to lower

TABLE 1. MISTLETOE AVERAGE DEFOLIATION SCORES AND POSSUM DENSITIES, MOERAKI-PARINGA.

LOCATION/LINE NUMBER	AVERAGE DEFOLIATION SCORE + (# OF PLANTS)			POSSUM NUMBERS (KILLS/TRAP NIGHT)		
	1990–91[1]	1991–92[2]	1993–94[3]	1990–91[1]	1991–92[2]	1994–95[4]
1 Moeraki – Middle Head TL 2 Moeraki – Middle Head TR	2.64 (78) 2.65 (37)	–	2.07 (82) 2.26 (38)	0	–	–
3 Moeraki – Horseshoe Flat TR 4 Moeraki – Horseshoe Flat TL	2.80 (35) 2.77 (84)	–	2.17 (35) 2.07 (87)	0.007	–	–
5 Windbag – Konini Ck 6 Windbag – Friends Ck	2.60 (60) 2.58 (69)	–	2.04 (51) 1.92 (65)	0.08	–	0.084
7 Jamie Ck	–	2.00 (10)	1.60 (10)	–	0.32	0.116
8 Paringa	–	1.51 (29)	0.65 (34)	–	0.31	0.116
9 Boulder Ck	–	–	1.98 (44)	–	–	0.017
10 Kaka Ck	–	–	2.26 (42)	–	–	0.034

[1]Buglass 1991, unpublished DoC report, Hokitika.
[2]Farrell 1992, unpublished DoC report, Hokitika.
[3]Lamoureaux & Van Uden 1994, unpublished DoC report, Hokitika.
[4]Terry Farrell pers. comm.

possum numbers, and perhaps winter snow damage (in 1992) or other climatic impacts. Further mistletoe and possum monitoring is required.

The final desirable possum density to maintain mistletoe populations in these forests has yet to be determined. Wilson (1984) found that only two possums per ha in Nelson beech forests were sufficient to cause mistletoe decline. Flowering and seed production are greatly reduced by persistent browsing of mistletoe plants. “The long term survival of mistletoe in South Westland will probably depend upon management of possum densities to nil or very low densities” (Buglass 1991). The most likely management option will be ground based hunting of large areas of forest on a regular rotation, at a frequency and to a target possum density yet to be determined.

To provide more conclusive data on the relationship between mistletoes and possum densities, the mistletoe-possum monitoring programme will be extended by addition of two “controls” — an area in the Arawhata valley where possums will not be controlled, and some isolated trees supporting mistletoes in the Moeraki which will be fully protected from possums by tree coils (= zero possum density). The health of host plants, where this is impacting on the mistletoe plants, will also be monitored.

It may be that possum control is not enough to protect mistletoes on the West Coast. The role of birds in mistletoe pollination and dispersal, and of predators in reducing bird populations, are essential future research projects (Ladley & Kelly 1995).

6. ACKNOWLEDGEMENTS

Thanks to Terry Farrell (DOC, Hokitika) for unpublished information, and Terry Farrell and Craig Miller (DOC, Hokitika) for reviewing a draft manuscript.

7. REFERENCES

Brockie, R. 1992. A living New Zealand forest. David Bateman, Auckland.

Farrell, T.J. 1990. Addition to the Moeraki-Paringa mistletoe study established 1991. Unpublished file note, Department of Conservation, Hokitika.

Ladley, J., Kelly, D. 1995. Mistletoes: How these showy specialists and honeyeaters need each other. *Forest & Bird* 278, 16–21.

Owen, H.J., Norton, D.A. 1995. The diet of introduced brushtail possums *Trichosurus vulpecula* in a low diversity New Zealand *Nothofagus* forest and possible implications for conservation management. *Biological Conservation* 71, 339–345.

Norton, D.A. 1993. Mainland Habitat Islands: A Vision for New Zealand Nature Conservation. *West Coast Conservancy Technical Report Series No.2*, Department of Conservation, Hokitika.

Pracy, L.T. 1980. Distribution – North and South Islands. In, Anon. (editor), Opossum Survey Report, Agricultural Pests Destruction Council, Wellington.

Rose, A.B., Pekelharing, C.J., Platt, K.H., Woolmore, C.B. 1993. Impact of invading brushtail possum populations on mixed beech-broadleaved forests, South Westland, New Zealand. *New Zealand Journal of Ecology* 17, 19–28.

Monitoring a population of the mistletoe *Ileostylus micranthus* near Wanganui

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SUMMARY

Plants of the mistletoe *Ileostylus micranthus* have been measured beside State Highway 4 near Aberfeldy, Wanganui in 1990, 1992 and 1994. The three surveys show that mistletoe recruitment has increased over this period, and especially between 1992 and 1994, and that this has occurred without any conservation management specifically for the mistletoe. At the levels recorded in 1994, survival of adult plants and recruitment of juveniles appears to be sufficient for the retention of mistletoes at this site over the next few years.

1. BACKGROUND

Plants of the mistletoe *Ileostylus micranthus* were first documented beside State Highway 4 near Aberfeldy, Wanganui, in September 1988 (CHR 464143), although they had been seen in the same place some 20 years earlier by Neill Simpson (Department of Conservation, Queenstown, pers. comm. 1995). The only known host plant here is hawthorn (*Crataegus monogyna*), occurring as scattered trees in pasture on a steep hill slope. As the only population of a leafy mistletoe species near Wanganui at the time, it was used in July 1990 to set up a monitoring study, with repeat surveys at two-year intervals, in 1992 and 1994.

2. METHODS

Surveys of the Aberfeldy mistletoes have been made in winter, when the mistletoes were easily seen on the deciduous hawthorn trees. Each survey took one day for about eight personnel, comprising staff of the Department of Conservation's Wanganui Conservancy and members of the Wanganui Regional Museum's Botanical Group.

In 1990, each host tree supporting a mistletoe was permanently identified with a numbered aluminium tag and a similar tag was wired on or close to each mistletoe plant that could be reached. Records were made of the diameter of host tree trunks, the greatest diameter and number of primary branches of each mistletoe bush, and whether the mistletoes were fertile (fruit or young flower buds) or had been browsed by possums.

Barkla, J. & Ogle, C. Monitoring a population of the mistletoe *Ileostylus micranthus* near Wanganui. Pp. 193–195 *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.

In the 1992 and 1994 surveys, newly discovered host plants and mistletoes were permanently tagged and the same parameters recorded. Notes were made of plants which had died or apparently disappeared after being recorded previously.

3. RESULTS

Sixty-six mistletoe plants were recorded in 1990 on 33 hawthorn trees, which increased to 71 mistletoe plants on 36 plants in 1992, and 118 plants on 41 trees in 1994. In each of the three surveys, more than 75% of the host trees with mistletoes had either one or two mistletoe plants. However, the number of mistletoe plants per host ranged up to eight in both 1990 and 1992, and two host trees had 18 and 30 mistletoe plants respectively, in 1994.

Few mistletoes were found in the 1–20 cm diameter size classes in 1990 and 1992, but almost half the population fell in these size classes in 1994.

4. DISCUSSION

Ileostylus micranthus have been known on the hawthorn trees of Aberfeldy Hill for more than 20 years. Growth rates of individual marked mistletoe shrubs in the 1990–94 period suggest that the largest specimens are a decade or more old. However, our study has shown that the population is increasing, particularly in the 1992–94 period, with most of the increase being of small (<20 cm diameter) and, presumably, young plants.

The recent increase in young plants may have been the result of more successful pollination, fruit set, fruit dispersal, or germination, seedling establishment, or some other factor or combination of factors.

If there had been a reduction in possum browsing over the study period, mistletoe recruitment may have been enhanced. We have no direct measures of possum densities in the study area, but possum browse sign was found on mistletoes during each of the three surveys. The number of mistletoes with browse damage declined between the first and second surveys and again between the second and third surveys. This decline may reflect an increased awareness since 1990 that mistletoes are damaged by other agents, including insects, and perhaps differences between observers. However, it does appear that possum impacts were less in the 1992–94 period than in the 1990–92 period.

We have not recorded mistletoes on other species of potential host plants in and near the study area[1], including indigenous shrubs and trees along road sides and in gullies. These observations lead us to suggest that the thorny nature of hawthorn acts as a partial deterrent to possums, especially if the possum density is low.

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[1] We found *Ileostylus micranthus* in 1995 some 17 km south of the Aberfeldy study area, in a private garden on the fringe of Wanganui. The host plants were silver birch (*Betula pendula*) and pear (*Pyrus communis*).

Our series of three surveys at two-year intervals in one site has shown that mistletoe recruitment has increased in the period 1990–94, especially between 1992 and 1994. This has occurred without any conservation management specifically for the mistletoe. At the levels recorded in 1994, survival of adult plants and recruitment of juveniles appears to be sufficient for the retention of mistletoes at this site over the next few years.

The Aberfeldy population of *I. micranthus* will be re-surveyed in July 1996, a detailed analysis made of the data, and an account written for publication. This account will include discussion of parameters not reported on in this paper because no clear trends could be seen in existing data.

Propagation of mistletoes in the central North Island

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SUMMARY

Aspects of a preliminary study involving the propagation of five loranthaceous mistletoe taxa (*Alepis flavida*, *Ileostylus micranthus*, *Peraxilla colensoi*, *P. tetrapetala* and *Tupeia antarctica*) using central North Island stock is discussed. The research is still in its initial stages and as such no significant conclusions are provided.

1. INTRODUCTION

The reproductive ecology of New Zealand's loranthaceous mistletoes has only recently been documented, with many facets still to be fully explored. As part of my thesis, I am investigating the prospect of propagating mistletoes as a way to reverse their continuing decline in most parts of the country. This work is being carried out on the five extant leafy mistletoe species present in the Tongariro-Taupo Conservancy in conjunction with Suzan Dopson, Victoria University and is part of a national programme on mistletoes. Trials began in May 1995, therefore results to date are preliminary only. However, I can present results so far in relation to what I believe are the four crucial stages for successful propagation of mistletoes.

The four stages are: (i) Germination; (ii) Survival; (iii) Establishment; (iv) Long-term establishment.

1. GERMINATION

Trials began on *Alepis flavida* in late May 1996 and are ongoing for this species and the other four Loranthaceae mistletoe species — *Ileostylus micranthus*, *Peraxilla colensoi*, *P. tetrapetala*, and *Tupeia antarctica*. Initially, fruit was collected off the ground, seeds removed and placed on variously sized branches of potential hosts in the vicinity of where the fruit was collected. Branch diameters used range from < 5 mm to > 25 mm. At this early stage, I was concerned about the viability of the seed taken from fruit collected off the ground as I had observed that the fruit deteriorates quickly once it is removed from the plant. This possibility was of particular concern for *Peraxilla colensoi* as the individual plants grow 20 m above the ground and therefore collecting fruit from the plant itself was not practicable.

Milne, R. Propagation of mistletoes in the central North Island. Pp. 197–199 *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.

To address this concern, fruit was taken to conduct germination tests to see if:

1. the seed was still viable, and

2. if so, the percent germination that could be expected.

Results

Tables 1 and 2 show high rates of germination can be expected. The concern about viability of seed from fruit off the ground would appear to be unfounded. Germination rates of seeds in the field are less than those of seeds in the glasshouse but differences in rates are considered only preliminary at this stage.

TABLE 1. GERMINATION RATES OF MISTLETOE SEEDS IN THE GLASSHOUSE.

SPECIES	NO. OF SEEDS	% GERMINATION	DATE LAST CHECKED
Alepis flavida	78	73	3/8/95
Ileostylus micranthus	89	100	17/8.95
Peraxilla colensoi	94	96	21/7/95
P. tetrapetala	49	98	3/8/95
Tupeia antarctica	13	77	8/9/95

TABLE 2. GERMINATION RATE OF MISTLETOE SEEDS IN THE FIELD.

SPECIES	NO. OF SEEDS	% GERMINATION	DATE LAST CHECKED
Alepis flavida	59	71	30/8/95
Ileostylus micranthus	17	71	2/8/95
Peraxilla colensoi	16	100	7/8/95
P. tetrapetala	20	0	5/8/95
Tupeia antarctica	38	95	2/9/95

2. SURVIVAL

Assessment of the survival of germinated seed is another objective of my research; for although high rates of germination occurred in the laboratory, the survival of germinated seed in the wild remained untested. (Table 3).

TABLE 3. SURVIVAL RATE OF SEEDS IN THE FIELD.

SPECIES	NO. OF SEEDS	% SURVIVAL	DATE LAST CHECKED
Alepis flavida	116	53	30/8/95
Ileostylus micranthus	20	85	2/8/95
Peraxilla colensoi	77	27	7/8/95
P. tetrapetala	25	84	5/8/95
Tupeia antarctica	40	95	2/9/95

As can be seen from the *Alepis flavida* and *Peraxilla colensoi* results, many germinated seeds fail to survive. The majority of losses occurred through the seeds being washed off branches. I have seen seeds slide to the underside of branches after rain had fallen and before the viscin had firmly attached the seeds to the branch. The crucial period for the seeds to firmly attach appears to be anytime up to 48 hours after the seed is placed. However, rehydration of the viscin has occurred in some seeds weeks after they were placed on a branch. When this has occured, the seed has generally remained attached to the branch, although not necessarily in its original place. Placement of seeds in crotches of branches increased their survival.

3. ESTABLISHMENT AND LONG-TERM ESTABLISHMENT

Beacause of the short time my trials have been operating, I have yet to obtain any information from them on establishment and long-term establishment of seedlings. Establishment is expected to take from 6-9 months and continuous monitoring is required. What I hope to demonstrate is the critical branch diameter range for successful establishment. These results will be presented and discussed in my thesis which is due to be completed by 31 June 1996. The issue of long-term establishment is therefore beyond the time frame of this study. However, I am hopeful that any seeds that do manage to establish will be monitored to determine the rate of long-term establishment. Host trees, as well as position of seeds along branches, have been marked for this purpose.

Discussion on management techniques

Facilitated by **Carol West**
Transcribed by **Suzanne Clegg**

The following notes have been taken directly from the taped discussion at the meeting and have only been edited for clarity.

(Following John Barkla's talk)

Points made:

- Tag individual plants, then you can look at growth rates in detail (CW).
- Long-term information is valuable (DN).
- Opportunities for restoration: planting native host trees adjacent to mistletoe sites (e.g., farm habitats, if farmers are conducive to the idea).
- Aging mistletoes. Look at leaf scars.
- John's 6 yr study is excellent, needs to be continued 1 more yr.

(Following Randel Milne's talk)

Points made:

- From NR's work (and casual observation) I suspect there is selection for particular mistletoe/host genotype combinations – important implications for transplanting (NR).
- Work on genotypic variation in beech has already been done but not on the beech mistletoes.
- Many exotic hosts. The 2 spp. of mistletoe that do well on exotics have been in NZ the shortest time – perhaps physiological system not so specialised yet.
- Anomalies e.g., *Ileostylus* on *Coprosma propinqua* mostly, though other hosts available.

⇒poorly understood (does attachment depend on something physical or physiological).

Discussion on Threatened Plant Database

- If you want to keep it going, please send in site reports (PdL).
- Don't know how to use it, too hard, H.O. mucks around, so Conservancies make their own (CJ, JR).
- Someone in H.O. should keep a national focus.

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Part 6 Discussion on the development of a mistletoe strategy

Discussion on the development of a mistletoe strategy

Facilitated by **Suzanne Clegg**
Transcribed by **Suzanne Clegg**

The following notes have been taken directly from the taped discussion at the meeting and have only been edited for clarity.

Everyone agreed that a strategy/plan of some sort is required. A strategy will provide direction and priorities (agreed upon through discussion) and encourage sharing of knowledge and skills (SC).

Outline of a possible mistletoe strategy presented (see separate pages).

Comments made:

- Do we want to provide direction for what should be done with land containing mistletoes, e.g., through RMA, District Schemes? (GL).This could be covered in advocacy section (DN).
- Should have "Survey **and** Protection" since survey will lead to opportunities for protection (GW).
- *Korthalsella* species (concerns raised). Suggest we include a separate section flagging them as an issue needing more attention – but package the strategy as Loranthaceous mistletoes. Identify what we do/don't know. Need some idea of habitats and their vulnerability (CW). Tell staff to keep looking for *Korthalsella*. *K. salicornioides* of concern, others appear to be OK (PdL).
- Distribution map will be updated and circulated to Conservancies (DN).
- Should we have a time frame in the strategy? At least, set priorities.
- Need a prototype survey form (GW).
- National overview or Regional? National, but up to Conservancies to pull out their bits and take a regional focus (Note: my interpretation – answer unclear) (SC).
- Need to take an ecosystem approach – will include this under "significance".
- Need to include list of species requirements for each species to persist and the threats at each point in the life cycle (JS). Important to emphasise dependence on hosts and birds.
- (Something about site reports) – accuracy (lack of) is a problem, need photos to be reliable.
- Past distribution – what about Landcare database (AB). Huge task to search it for the whole country (DN). Very important for Canterbury (AB).

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- Archival information (e.g., early explorers) on unmodified habitats (GW) – when we refer to this we need to have the comments, not just a reference (GL). Up to conservancies to provide this info to DN/PdL.
- GOAL → change to VISION (GW). Should be based on those quotes from early explorers i.e., protect and restore to how it used to be. Need an optimistic vision or we'll never get anywhere (DN). The nature of the vision is also important to the public, e.g., "The Tararuas will be aglow with mistletoes!".

Advocacy

- You need to contribute photos to the S&R library.
- Combine your efforts, e.g., contact GW on advocacy material.
- Need a field guide with pictures of mistletoes, browse etc. (PdL & JS).
- Short-term Goals (discussion relating to goals – on separate page).
  - Need to sort out advocacy right at the beginning.
  - Benchmark sites: South Westland and Waitutu are logical, what are others? (DN).
  - Te Urewera, Tong/Taupo – got to get away from South Island focus (PdL)
  - No! nationally, SW & W are **the** benchmark sites (GL). Others are regional.
  - The goal has to be to maintain all known sites – don't lose any (DN).
  - Is it valid in the South Island to chase our tails for the last few *Peraxilla* in an Ecological District? (GL). **You** will have to decide. "Representative" means you can interpret it how you like (PdL).
  - We should record, in detail, substantial mortality events, because ordinary monitoring doesn't look at the cause (GL).

Research

Discussion:

- We need to know what Conservancy people need, rather than academic questions (DN).
- Overall goal of research should be to determine causes of decline, then everything else fits in under that (SC).
- Debate over whether propagation etc. is a priority. Irrelevant for South Island (GL).– Disagree – Australian work showed that host specificity can have significant management implications. Very important in fragmented habitat (DN).
- Role of pollination/dispersal vectors – maybe one of these mistletoe monitoring programmes could be run in conjunction with a "mainland island" project (LF).

⇒ some of the more obscure research topics will be good for Ph.D. students. They might not stack up management-wise but could turn out to be very important.

Monitoring

Discussion:

- We need to know (DN) (i) health/condition of mistletoes and host; (ii) population size and abundance of mistletoes; (iii) how to sample within an area, i.e., in more detail.
- We need to have two systems (CW) (i) broad scale, done by anyone, report immediately; (ii) detailed, similar to what we do now.
- Agreed that we need a standard scale for health/condition – consult with Landcare (informally) and amongst ourselves.
- Must score browse, crown damage etc. separately (and for mistletoe and host) (LF).
- Need to monitor regularly enough to detect sudden change (GL).
- Could record presence/absence of mistletoes in trees (GL).
- Could use an altitudinal transect line and sample plots at intervals (DN).

- Must use the same number of trees each time (DN).
- Timing of monitoring is critical – winter, **not** spring flush (DN).
- Can we determine % of mistletoe flowers, leaves in possum guts? (JR). Flowers difficult (and fruit) – depends what else is there. Flowering is not the key. It is whether recruitment is occurring (DN).
- Note that we will be monitoring for different purposes eg., if we are doing performance monitoring for possum control we will look at different aspects than if we were looking at population dynamics (CW).
- Should look at cause of dead branches – some confusion, not always due to possums (GL).

Summing up (DN)

Pleased with level of agreement. Confident we can come up with a national strategy (not a "recovery" plan in true sense).

Objective of this workshop (sorry, should've been at the start!) (PdL)

Over last five years mistletoes have become trendy, lots of work done and research proposals put forward ⇒ lots done but we're not sure what we're aiming for. First objective is bring people together, look at what we do/don't know, assess regionally/nationally. I feel central coordination necessary. Sick of getting research bids where there has been no communication.

At some stage we will have to integrate other strategies/plans (GW).

Part 7 Bibliography of New Zealand mistletoes

Annotated bibliography for New Zealand viscaceous and loranthaceous mistletoes

This bibliography lists all known publications dealing with New Zealand mistletoes, including taxonomic treatments, but excludes articles that simply list the presence of mistletoes without any further information. We have added a brief comment on each publication to indicate the general nature of the material covered.

Aiken, M.A. 1957. Plant pirates, some New Zealand parasitic plants. *Tuatara* 6, 87–95. [*Gives brief descriptions of all parasitic plants found in New Zealand*.]

Allan, H. 1943. Unusual hosts for mistletoes. *Bulletin of the Wellington Botanical Society* 11, 12. [*Provides a list of unusual host species, and general locations, for* I. micranthus *and* P. colensoi *plants*.]

Allan, H.H. 1961. Flora of New Zealand, Vol. 1. Government Printer, Wellington. [*Taxonomic treatment of Viscaceae and Loranthaceae*.]

Atkinson, I.A.E. 1992. Effects of possums on the vegetation of Kapiti Island and changes following possum eradication. DSIR Land Resources Contract Report 92/52. [*Discusses the effect of possum eradication on the* I. micranthus *population on the island*.]

Bannister, P. 1989. Nitrogen concentration and mimicry in some New Zealand mistletoes. *Oecologia* 79, 128–132. [*Presents evidence to suggest that host mimicry may occur in New Zealand mistletoes*.]

Barlow, B.A. 1965. Classification of the Loranthaceae and Viscaceae. *Proceedings of the Linnean Society of New South Wales* 89, 268–272. [*Revises classification of Loranthaceae s.l. and accepts Viscaceae as a distinct family*.]

Barlow, B.A. 1966. A revision of the Loranthaceae of Australia and New Zealand. *Australian Journal of Botany* 14, 421–499. [*Detailed taxonomic revision of New Zealand Loranthaceae*.]

Barlow, B.A. 1983. Biogeography of Loranthaceae and Viscaceae. In, M. Calder & P. Bernhardt, editors, The Biology of Mistletoes. Academic Press, Sydney. Pp 19–46. [*General discussion on biogeography of New Zealand and Australian mistletoes*.]

Beuzenberg, E.J., Groves, B.E. 1974. Contributions to a chromosome atlas of the New Zealand flora – 16. Miscellaneous families. *New Zealand Journal of Botany* 12, 211–217. [*Provides chromosome numbers for all extant New Zealand loranthaceous and viscaceous mistletoes*.]

Bloor, S.J., Molloy, B.P.J. 1991. Cytotoxic norditerpene lactones from *Ileostylus micranthus*. *Journal of Natural Products* 54, 1326–1330. [*Describes several cytotoxic compounds found in extracts from* Ileostylus micranthus *plants and proposes that these compounds have been assimilated from the host* Podocarpus totara *plants*.]

Brooker, S.G., Cambie, R.C., Cooper, R.C. 1987. *New Zealand Medicinal Plants*. Heineman, Auckland. [*Medicinal use of New Zealand's mistletoes*.]

Cameron, E.K., de Lange, P.J., Given, D.R., Johnson, P.N., Ogle, C.C. 1995. New Zealand Botanical Society Threatened and local plant lists (1995 revision). *New Zealand Botanical Society Newsletter* 39**,** 15–28. [*National list of indigenous threatened vascular plants. Shows committee rankings for all indigenous loranthaceous and one viscaceous mistletoe*.]

Cheeseman, T.F. 1881. Description of a new species of *Loranthus*. *Transactions of the New Zealand Institute* 13, 296–297. [*Paper with the formal latin description of* Loranthus adamsii *now* Trilepidea adamsii.]

Cheeseman, T.F. 1925. *Manual of the New Zealand Flora, second edition.* Government Printer, Wellington. [*Provides descriptions and important notes on distribution, hosts and general ecology of our indigenous Loranthaceae mistletoes*.]

Cockayne, L. 1926. Monograph on the New Zealand Beech Forests, Part 1: The Ecology of the Forests and the Taxonomy of the Beeches. *New Zealand Forest Service Bulletin* 4. 71 p. [*Discusses the beech mistletoes and their general ecology, and notes that they can kill young saplings of host trees*.]

Cockayne, L. 1928. The Vegetation of New Zealand, third edition. Engelmann, Leipzig. [*Discusses the ecology of our indigenous Loranthaceae mistletoes.*]

Coetzee, J., Fineran, B.A. 1987. The apoplastic continuum, nutrient absorption and plasmatubules in the dwarf mistletoe *Korthalsella lindsayi* (Viscaceae). *Protoplasma* 136, 145–153. [*Investigation at cellular level of how water and nutrients are passed from the host to the mistletoe.*]

Coetzee, J., Fineran, B.A. 1989. Translocation of lysine from the host *Melicope simplex* to the parasitic dwarf mistletoe *Korthalsella lindsayi* (Viscaceae). *New Phytologist* 112, 377–381. [*Apoplastic transportation of organic and inorganic solutes from host tissue to Korthalsella tissue*.]

Cockayne, L., Allan, H.H. 1934. An annotated list of groups of wild hybrids in the New Zealand flora. *Annals of Botany* 48, 1–55. [*Documents possible hybrids between* Alepis flavida *and* Peraxilla *species*.]

Condon, J., Kuijt, J. 1994. Anatomy and ultrastructure of the primary endophyte of *Ileostylus micranthus* (Loranthaceae). *International Journal of Plant Science* 155, 350–364. [*Descriptive account of the established endophyte of primary haustoria of* Ileostylus.]

Connor, H.E., Edgar, E. 1987. Name changes in the indigenous New Zealand flora, 1960–1986 and nomina nova IV, 1983–1986. *New Zealand Journal of Botany* 25, 115–170. [*Notes the taxonomic changes made by Barlow (1965, 1966) that are relevant to New Zealand Viscaceae and Loranthaceae*.]

de Lange, P.J. 1987. A fading flower – the park's mistletoe. *Tongariro* 28, 8–11. [*Popularised account of the plight of loranthaceous mistletoes within the Tongariro National Park*.]

de Lange, P.J. 1994. Storm damages Kaiaua mistletoe. *Rare Bits* 16, 12. Newsletter of the Threatened Species Unit, Department of Conservation. [*Notes severe damage to a small mistletoe population following heavy rain.*]

de Lange, P.J. 1994. Host specificity in leafy mistletoes. *Rare Bits* 16, 11. Newsletter of the Threatened Species Unit, Department of Conservation. [*Request for verified samples of mistletoe hosts, discusses importance of obtaining host information for conservation purposes*.]

de Lange, P.J., Norton, D. 1995. Request for mistletoe/host vouchers. *Rare Bits* 20, 22–24. Newsletter of the Threatened Species Unit, Department of Conservation. [*Discusses the importance of verifying hosts for mistletoe species and lists those not verified.*]

de Lange, P.J., Norton, D.A., Molloy, B.P.J. 1996. A revised checklist of New Zealand mistletoe (Loranthaceae) hosts. *New Zealand Botanical Society Newsletter* 44, 15–24. [*All known hosts of N.Z. Loranthaceous mistletoes are documented. Updates Norton* et al*. 1994*.]

de Lange, P.J. 1997. Of mistletoes, kings, poor puddings and things. *Rare Bits* 24, 24–28. [*Discusses host preferences and germination studies of New Zealand mistletoes*.]

Dugdale, J.S. 1974. Plant-eating insects. *New Zealand's Natural Heritage* 3(39), 1069–1075. [*Describes a species of looper caterpillar found on a native mistletoe.*]

Dawson, J., Lucas, R. 1993. *Lifestyles of New Zealand's Forest Plants*. Victoria University Press, Wellington. [*Elaborates on the lifestyle of our indigenous loranthaceous mistletoes.*]

Duguid, F.C. 1967. Hosts of *Loranthus micranthus*. *Wellington Botanical Society Bulletin* 34, 23–24. [*Provides a list of mistletoe hosts and discusses some facets of the ecology of* Ileostylus.]

Eagle, A. 1975. Eagle's Trees and Shrubs of New Zealand, Vol. 1. Collins, Auckland. [*Illustrations of all indigenous loranthaceous and viscaceous taxa, some notes on distribution and hosts provided*.]

Engler, A., Krause, K. 1935. Loranthaceae, In Die Natürlichen Pflanzenfamilien. Auf. 2. 16p. [*Revision of world Loranthaceae, places New Zealand species within the genera* Elytranthe, Loranthus, Phrygilanthus *and* Tupeia.]

Field, H.C. 1884. Notes on *Loranthus fieldii*, Buchanan. *Transactions and Proceedings of the New Zealand Institute* 17, 288–290. [*Discusses the general morphology and biology of this species, now included within* Peraxilla tetrapetala.]

Fineran, B.A. 1974. Parasitic flowering plants. In New Zealand's Nature Heritage, Hamlyns, Hong Kong. Pp 637–641. [*Popularised account of the general biology and haustorial attachments of New Zealand's parasitic plants.*]

Fineran, B.A. 1987. A structural approach towards investigating transport systems between host and parasite, as exemplified by some mistletoes and root parasites. In H. C. Weber & W. Forstreuter, editors, Parasitic Flowering Plants. Proceedings of the 4th International Symposium, Philipps University, Marburg. Pp 201–220. [*Outlines experiments to demonstrate transport pathways between host and parasite.*]

Fineran, B.A. 1995. Green tissue within the haustorium of the dwarf mistletoe *Korthalsella* (Viscaceae). An ultrastructural comparison between chloroplasts of sucker and aerial stem tissue. *Protoplasma* 189, 216–228. [*Describes chloroplasts found in the haustoria*.]

Fineran, B.A. 1996. Flange-type parenchyma cells: occurrence and structure in the haustorium of the dwarf mistletoe *Korthalsella* (Viscaceae). *Protoplasma* 194, 40–53. [*Describes unusual cells in haustorium*.]

Given, D.R. 1981. Rare and endangered plants of New Zealand. Reed, Wellington. [*Discusses the possible extinction of* Trilepidea adamsii.]

Hollinger, D.Y. 1989. Canopy organisation and foliage photosynthetic capacity in a broad-leaved evergreen montane forest. *Functional Ecology* 3, 53–62. [*Provides leaf area index, stem silhouette area index, leaf biomass and Nitrogen mass measurements for* A. flavida.]

Jones, C. 1993. Protection measures for mistletoes in Tongariro-Taupo Conservancy. *Ecological Management* 1, 1–3. [*Advocates and describes banding as a means of protecting mistletoes from possum browse*.]

Kirk, T. 1876. On a remarkable instance of double parasitism in Loranthaceae. *Transactions and proceedings of the New Zealand Institute* 8, 329–330. [*Describes a very unusual case of* Tupeia antarctica *on* Peraxilla tetrapetala.]

Kuijt, J. 1969. The Biology of Parasitic flowering Plants. University of California Press, Los Angles. [*Thorough introduction to many aspects of the ecology of parasitic plants. New Zealand mistletoes mentioned*.]

Kuijt, J. 1981. Inflorescence morphology of Loranthaceae – an evolutionary synthesis. *Blumea* 27, 1–73. [*Describes the inflorescence structure of Loranthaceae mistletoes*.]

Ladley, J.J. 1994. The reproductive ecology of the Loranthaceae mistletoes of New Zealand. Unpublished M.Sc. thesis, University of Canterbury, Christchurch. [*Study on the reproductive ecology of New Zealand's lornathaceous mistletoes*.]

Ladley, J.J., Kelly, D. 1995. Mistletoes: How these showy specialists and honeyeaters need each other. *Forest & Bird* 278, 16–21. [*Popularised account of the floral biology and conservation of New Zealand's loranthaceous mistletoes.*]

Ladley, J.J., Kelly, D. 1995. Explosive New Zealand mistletoe. *Nature* 378, 766. [*Brief description of the explosive flower opening mechanism found in the two* Peraxilla *species*.]

Ladley, J.J., Kelly, D. 1996. Dispersal and Germination of the New Zealand Loranthaceae. *New Zealand Journal of Ecology, Supplement*, in press. [*Provides an introduction to the dispersal, germination and establishment of the loranthaceae mistletoes of New Zealand*.]

Laing, R.M., Blackwell, E.W. 1940. Plants of New Zealand. Whitcombe & Tombs Ltd, Auckland. [*General description of New Zealand's Loranthaceae and Viscaceae mistletoes*.]

Malcolm, A.N. 1993. *Ileostylus micranthus* at 3 Mile Lagoon, Westland, New Zealand: Population structure and density, and the implications for conservation. Unpublished B.For.Sc. dissertation, University of Canterbury. [*Account of the population structure of a saltmarsh* Ileostylus micranthus *population*.]

Martin, N.J. 1983. Nuclear DNA variation in the Australasian Loranthaceae. In, M Calder & P Bernhardt, editors, The Biology of Mistletoes. Academic Press, Sydney. Pp 277–293. [*Includes data on the relative DNA content of New Zealand loranths and discussion on DNA evolution within the Loranthaceae*.]

Mason, R. 1958. Foods of the Australian opossum (*Trichosurus vulpecula* Kerr.) in New Zealand indigenous forest in the Orongorongo Valley, Wellington. *New Zealand Journal of Science* 1, 590–613. [*Documents mistletoes in possum diet*.]

Menzies, B.P. 1947. Some observations on the parasitic species *Loranthus micranthus* (Hook.) Unpublished M.Sc. thesis, University of Auckland, Auckland. [*Distribution, means of dissemination morphology and anatomy of* Ileostylus micranthus.]

Menzies, B.P. 1954. Seedling development and haustorial system of *Loranthus micranthus* Hook. f. *Phytomorphology* 4, 397–409. [*The seedling and haustorial development of* Ileostylus *is discussed and compared with other Loranthaceae*.]

Mildenhall, D.C. 1980. New Zealand late Cretaceous and Cenozoic plant biogeography: a contribution. [*Palaeogeography, Palaeoclimatology, Palaeoecology* 31, 197–233. *Provides a detailed pollen record of the appearance of various Loranthaceae genera in New Zealand*.]

Molloy, B.P.J. 1990. Loranthaceae (large leafy mistletoes). In, A.L. Poole & N.M. Adams, Trees and Shrubs of New Zealand. Pp 120–124. DSIR Publishing, Wellington. [*An improved key to the indigenous New Zealand Loranthaceae is provided*.]

Molloy, B.P.J. 1990. Viscaceae (including dwarf mistletoes). In, A.L. Poole & N.M. Adams, Trees and Shrubs of New Zealand. Pp 124–126. DSIR Publishing, Wellington. [*An improved key to the indigenous New Zealand Viscaceae is provided*.]

Moore, L.B., Irwin, J.B. 1978. The Oxford Book of New Zealand Plants. Oxford University press, Wellington. [*Illustrations and life histories of* Ileostylus, Peraxilla, Tupeia *and* Korthalsella *are provided*.]

Moore, S. 1987. Mistletoes: are urban parks ideal habitat? *Wellington Botanical Society Bulletin* 43, 26–27. [*Notes an urban occurrence of* Ileostylus.]

Norton, D.A. 1991. *Trilepidea adamsii*: an obituary for a species. *Conservation Biology* 5, 52–57. [*Detailed review of factors leading to the extinction of* Trilepidea adamsii.]

Norton, D.A., de Lange, P.J., Ladley, J.J., Malcolm, A.N. 1994. Hosts of New Zealand Loranthaceae mistletoes. *New Zealand Botanical Society Newsletter* 37, 6–12. [*Preliminary list of hosts for all New Zealand loranthaceous mistletoes*.]

Norton, D.A., Ladley, J.J., Owen, H.J., in press. Distribution and population structure of the Loranthaceous mistletoes *Alepis flavida, Peraxilla colensoi* and *Peraxilla tetrapetala* within two New Zealand *Nothofagus* forests. *New Zealand Journal of Botany* 35(3). [*Describes distribution patterns and population structures of the three beech mistletoes in the South Island*.]

Norton, D.A., Ladley, J.J., Sparrow, A.D., in press. Development of non-destructive age indices for three New Zealand Loranthaceous mistletoes. *New Zealand journal of Botany* 35(3). [*A non-destructive method for estimating mistletoe age is presented*.]

Norton, D.A., Reid, N. 1997, in press. Lessons in ecosystem management from management of threatened and pest loranthaceous mistletoes in New Zealand and Australia. *Conservation Biology* 11. [*Reviews the ecology of loranthaceous mistletoes in Australia and New Zealand and points out similarities in the causes for their current status. Discusses the need for ecosystem management to deal with the current status of mistletoes in both countries*.]

O'Donnell, C.F.J., Dilks, P.J. 1986. Feeding of fruits and flowers by insectivorous forest birds. *Notornis* 36, 72–76. [*Mention of Yellowheads visiting* Peraxilla *plants*.]

O'Donnell, C.F.J., Dilks, P.J. 1994. Foods and foraging of forest birds in temperate rainforest, South Westland. New Zealand. *New Zealand Journal of Ecology* 18, 87–108. [*Mentions visitations by birds to* Peraxilla *plants*.]

Ogle, C.C., Wilson, P. 1985. Where have all the mistletoes gone? *Forest and Bird* 16 (3), 10–13. [*Popularised account suggesting that possums are responsible for a national decline in loranthaceous mistletoes*.]

Ogle, C. C. 1987. The incidence and conservation of animal and plant species in remnants of native vegetation within New Zealand. In, D.A. Saunders, G.W. Arnold, A.A. Burbidge and A.J.M. Hopkins, editors, Nature Conservation: The Role of Remnants of Native Vegetation. Surrey Beatty and Sons, Chipping Norton. Pp 79–87. [*Briefly discusses mistletoe distribution patterns in agricultural environments in New Zealand and compares with some Australian observations*.]

Owen, H.J. 1993. Mistletoe and brushtailed possum in silver beech forest, south Westland, New Zealand. Unpublished M.For.Sc. thesis, University of Canterbury, Christchurch. [*Assessment of the ecology of* Peraxilla colensoi *and evaluation of possum impacts*.]

Owen, H.J., Norton, D.A. 1995. The diet of introduced brushtail possums *Trichosurus vulpecula* in a low-diversity New Zealand *Nothofagus* forest and possible implications for conservation management. *Biological Conservation* 71, 339–345. [*Evaluation of possum diet, with comments on impacts on the mistletoe* Peraxilla colensoi.]

Patel, R.N. 1991. Wood anatomy of the dicotyledons indigenous to New Zealand. 21. Loranthaceae. *New Zealand Journal of Botany* 29, 429–449. [*Described the wood anatomy of New Zealand loranthaceous mistletoes, with some comments on taxonomic relationships*.]

Pocknell, D.T., Turnbull, I.M. 1989. Paleoenvironmental and stratigraphic significance of palynomorphs from Upper Eocene (Kaiatan) Beaumont Coal Measures and Orauea Mudstone, Waiau basin, western Southland, New Zealand. *New Zealand Journal of Geology and Geophysics* 32, 371–378. [*Fossil pollen record for the area*.]

Potts, T.H. 1882. *Out in the Open*: A Budget of Scraps of Natural History, Gathered in New Zealand. Lyttleton Times Company, Christchurch. [*A fascinating series of anecdotal accounts of mistletoe ecology from the early days of New Zealand European settlement*.]

Powell, G.R., Norton, D.A. 1994. Contrasts in crown development of the mistletoe *Alepis flavida* (Hook. f.) Tiegh. and *Peraxilla tetrapetala* (L. f.) Tiegh. (Loranthaceae) parasitic on *Nothofagus solandri* (Hook. f.) Oerst., Craigieburn Ecological District, New Zealand. *New Zealand Journal of Botany* 32, 497–508. [*Description of the growth architecture of two mistletoes and discusses implications of this for their ecology and possum impacts*.]

Prakash, S. 1960. Morphological and embryological studies in the Loranthaceae family – VI *Peraxilla tetrapetala*. *Phytomorphology* 10, 224–234. [*Drawings of buds and internal parts of fruit with some discussion on morphology and embryology*.]

Richards, E.C. 1956. Our New Zealand Trees and Flowers, third edition. Simpson & Williams Ltd, Christchurch. [*Popularised account of New Zealand flora, provides some valuable references to items such as vernaculars, flowering times and hosts of our indigenous loranthaceous mistletoes*.]

Salmon, J.T. 1991. Native New Zealand Flowering Plants. Reed, Auckland. [*Includes illustrations of loranthaceous mistletoes and provides some brief notes on phenology and distribution*.]

Simpson, M.J.A. 1976. *Elytranthe* in the vicinity of Nelson Lakes National Park. *Wellington Botanical Society Bulletin* 39, 39–40. [*Discusses the occurrence of* Peraxilla *mistletoe in the Nelson Lakes district*.]

Smart, C. 1949. The life history of the genus *Tupeia*. Unpublished M.Sc. thesis, University of Otago, Dunedin. [*General ecology of* Tupeia.]

Smart, C. 1952. The life history of *Tupeia* Cham. et Schl. (Loranthaceae). *Transactions of the Royal Society of New Zealand* 79, 459–466. [*The ontogeny of* Tupeia *is discussed*.]

Stevenson, G.B. 1934. The life history of the New Zealand species of the parasitic genus *Korthalsella*. *Transactions and Proceedings of the Royal Society of New Zealand* 64, 175–191. [*Overview of the life history of the* Korthalsella *species.*]

Sutherland, J.J. Burrows, C.J. Dugdale, J.S. 1995. Insect predation of seeds of native New Zealand woody plants in some central South Island localities. *New Zealand Journal of Botany* 33, 355–364. [*Describes the predation of immature* I. micranthus *fruits by lavae of the moth* Zelleria sphenota.]

Thomas, G. 1987. Growing mistletoes. *Wellington Botanical Society Bulletin* 43, 28–29. [*Discusses a means for propagating* Viscum album, *and suggests the same technique could be trialed for New Zealand mistletoes*.]

Thomson, G.M. 1927. The pollination of New Zealand flowers by birds and insects. *Transactions and Proceedings of the Royal Society of New Zealand* 57, 106–125. [*Description of the flowering of the Loranthaceae mistletoes*.]

Thomson, G. 1949. A natural hybrid between *Loranthus micranthus* and *Tupeia antarctica*. *Transactions of the Royal Society of New Zealand* 77, 208. [*Describes the flowering and fruit set on a mistletoe, thought to be a hybrid* between I. micranthus *and* T. antarctica.]

Van Tiegham, P. 1894. *Trithecanthera, Lysiana* et *Alepis*, trois genres nouveaux pour la famille des Loranthacée. *Bulletin of the Society for Botany, France* 41, 597–605. [*Defines the genus* Alepis.]

Van Tiegham, P. 1894. Quelques genres nouveaux pour la tribu des Loranthacées dans la famille des Loranthacées. *Bulletin of the Society for Botany, France* 41, 481–

489. [*Defines genera within Loranthaceae including several from New Zealand*.]

Wardle, J. 1984. *The New Zealand Beeches*. New Zealand Forest Service, Wellington. [*Discusses the possible effect of* Peraxilla *and* Alepis *on* Nothofagus *species in New Zealand*.]

Webb, C.J., Johnson, P.N., Sykes, W.R. 1990. *Flowering Plants of New Zealand*. DSIR Botany, Christchurch. [*A popular account of systematic arrangement of New Zealand flowering plants, including a section on Loranthaceae*.]

Weber, H.C. 1981. Untersuchungen an australischen und neusccländischen Loranthaceae/Viscaceae II. Uber Oberflächenstrukten von Blättern. *Beitraege zur biologie der pflanzen* 56, 479–512. [*Describes leaf morphology based on scanning electron microscopy*.]

Weber, H.C. 1984. Untersuchungen an australischen und neusccländischen Loranthaceae/Viscaceae III. Granulahaltige Xylem-Leitbahnen. *Beitraege zur biologie der pflanzen* 58, 303–320. [*Reports graniferous trachery elements in haustoria based on scanning electron microscopy*.]

Wilcox, M. 1984. Mistletoes in the Rotorua Lakes District. *Rotorua Botanical Society Newsletter* 3, 5. [*Notes distribution and host preferences of loranthaceous mistletoes around Rotorua*.]

Williams, R.W.M., Chavasse, C.G.R. 1951. The silviculture of silver beech in Southland. *New Zealand Journal of Forestry* 6, 219–235. [*Discusses a means of controlling mistletoes in beech forests managed for timber production*.]

Wilson, C.M., Given, D.R. 1989. Threatened Plants of New Zealand. DSIR Publishing, Wellington. [*Brief discussion of* Trilepidea adamsii *including a description and comments on its ecology and conservation*.]

Wilson, P.R. 1984. The effects of possums on mistletoe on Mt Misery, Nelson Lakes National Park. In P.R. Dingwall, editor, *Proceedings of 15th Pacific science congress, section A4E*. Dunedin, February 1983. Pp 57–60. Department of Lands and Survey, Wellington. [*Provides evidence that possums are having a severe impact on beech mistletoes*.]

Young, M. 1996. Information on the *Ileosytlus* intersection. *Auckland Botanical Society Journal* 51, 68–69. [A brief account of a recently rediscovered roadside population of *Ileostylus micranthus*, near Puhoi, Auckland.]

Part 8 Appendices

Appendix 1

Programme for Department of Conservation mistletoe workshop, Cass

MONDAY JULY 17TH

Participants arrive in Christchurch by 5 pm.
Takeaways for dinner and drive to University field-station at Cass.
Evening presentation on mistletoe taxonomy and biogeography (Brian Molloy, Landcare Research, Lincoln).

TUESDAY JULY 18TH

Past and present distribution of New Zealand mistletoes.

Facilitator – Suzanne Clegg

9.00 am Overview of historical distribution (Peter de Lange, Department of Conservation, Auckland)

9.30 am Reports from each conservancy (14) on current distribution (10 mins each)

Ecology of New Zealand mistletoes

Facilitator – Geoff Walls

1.00 pm Host specificity & spatial distribution patterns (David Norton, School of Forestry, University of Canterbury)

1.35 pm Reproductive biology of native Loranthaceae (Dave Kelly & Jenny Ladley, Department of Plant & Microbial Sciences, University of Canterbury and Kath Dickinson & Suzan Dopson, School of Biological Sciences, Victoria University of Wellington)

2.35 pm Anatomy and physiology of the mistletoe-host connection (Brian Fineran, Department of Plant & Microbial Sciences, University of Canterbury)

Threats to New Zealand mistletoes

3.30 pm Possum-mistletoe interactions #1 (Colin Ogle, Department of Conservation, Wanganui)

4.00 pm Possum-mistletoe interactions #2 (David Norton, School of Forestry, University of Canterbury)

4.30 pm Non-possum threats (Peter de Lange, Science & Research Division, Department of Conservation, Auckland)

5.00 pm Questions and discussion

Evening – Presentation on Australian mistletoe ecology and management (Nick Reid, Department of Ecosystem Management, University of New England, Armidale).

WEDNESDAY JULY 19TH

Morning – Field trip to Craigieburn Conservation Park to see *Peraxilla* and *Alepis*.

Current status and management solutions

Facilitator – Carol West

1.00 pm Background to IUCN classification scheme and possible alternative viewpoints (David Norton, School of Forestry, University of Canterbury)

1.30 pm Review of current views on status of New Zealand mistletoes (Peter de Lange, Department of Conservation, Auckland)

2.00 pm General discussion on current status

Current management

3.30 pm Mistletoe survey and management strategies, Tongariro-Taupo Conservancy (Cathy Jones, Department of Conservation, Turangi)

3.50 pm Mistletoe survey and management strategies, West Coast Conservancy (Fred Overmars, Department of Conservation, Hokitika)

4.10 pm Management of *Ileostylus micranthus*, Parapara, Wanganui Conservancy (John Barkla & Colin Ogle, Department of Conservation, Wanganui)

4.30 pm Mistletoe propagation (Randel Milne, School of Biological Sciences, Victoria University of Wellington)

4.50 pm General discussion on management approaches

Evening – Development of strategy for mistletoe conservation in New Zealand and discussion of recovery plan options (*Facilitator – Suzanne Clegg*)

THURSDAY JULY 20TH

9.00 am Continuation of strategy and recovery plan discussion (*Facilitator – Suzanne Clegg*)

11.00 am Clean field station

12 noon Depart for Christchurch

Appendix 2

Mistletoe workshop participants

Amanda Baird (Canterbury Conservancy, Christchurch)
John Barkla (Wanganui Conservancy, Wanganui)
Suzanne Clegg (Threatened Species Unit, Wellington)
Shannel Courtney (Nelson/Marlborough Conservancy)
Peter de Lange (Science and Research Division, Auckland)
Kath Dickinson (Victoria University, Wellington)
Suzan Dopson (Victoria University, Wellington)
Brian Fineran (University of Canterbury, Christchurch)
John Flemming (Otago Conservancy, Wanaka)
Lisa Forester (Northland Conservancy, Whangerai)
Cathy Jones (Tongariro/Taupo Conservancy, Turangi)
Dave Kelly (University of Canterbury, Christchurch)
Dave King (East Coast Conservancy, Gisborne)
Jenny Ladley (University of Canterbury, Christchurch)
Graeme Loh (Otago Conservancy, Dunedin)
Paul McArthur (Nelson/Marlborough Conservancy, St Arnaud)
Randel Milne (Victoria University, Wellington)
Brian Molloy (Landcare Research, Lincoln)
David Norton (University of Canterbury, Christchurch)
Colin Ogle (Wanganui Conservancy, Wanganui)
Fred Overmars (West Coast Conservancy, Hokitika)
George Pardy (Bay of Plenty Conservancy, Rotorua)
Nick Reid (University of New England, Armidale, NSW)
Jason Roxburgh (Waikato Conservancy, Hamilton)
John Sawyers (Wellington Conservancy, Wellington)
Neil Simpson (Otago Conservancy, Queenstown)
Geoff Walls (Hawkes Bay Conservancy, Napier)
Carol West (Southland Conservancy, Invercargill)