is wrong. Chamisso and Schlechtendal (1828) dedicated their genus to Tupaia, the Tahitian whom Cook took to New Zealand on his first voyage and who died in Batavia on the journey home. They wrote: "TUPEIA *antarctica* N. [obis], nomine Taheitensis amabilis peregrinatoris, in primo Cookii itinere de scientiis bene meritii".

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■ A guide to hand-planting of New Zealand mistletoes (Loranthaceae)

Mistletoes are curious plants. Their parasitic lifestyle means that a clump of mistletoe foliage can be very conspicuous, appearing to almost perch in a tree of another species. New Zealands five remaining species of Loranthaceae mistletoes, *Alepis flavida*, *Ileostylus micranthus*, *Peraxilla colensoi*, *P. tetrapetala* and *Tupeia antarctica*, have all declined in abundance in recent decades. Three main reasons have been suggested for this decline. These are loss of habitat, decline in the numbers of dispersal agents (in particular frugivorus birds), and the detrimental effect of introduced herbivores, especially possums (Norton 1991; Ladley & Kelly 1996; Norton & Reid 1997; de Lange & Norton 1997). A number of people, motivated either by curiosity or by conservation, are interested in artificially establishing mistletoes on hosts. In some cases this is to cultivate the plant in a garden or farm situation; in others its to augment or establish a population in the wild. However there has been little published information on the best way to go about hand sowing of New Zealands mistletoes (Thomas 1987; Ogle 1988, Milne 1996).

As part of an ongoing research project funded by the PGSF into the reproductive ecology of these mistletoes, we have been attempting to plant and establish seedlings. We have managed to successfully establish a number of mistletoe seedlings, especially of *A. flavida*, *P. tetrapetala* and *P. colensoi*. Having been asked several times for guidelines on how to do this, it seemed worthwhile to document some tips that we have learnt over the last few years that seem to have increased the chance of successfully planting mistletoe seeds.

Seed collection

First it must be stressed that removal of seed from Department of Conservation land requires a permit. On private land, the permission of the landowner would be required; some populations (e.g., on roadsides) may not require formal permission. As well as verifying that you have legal permission, ripe fruits should not be removed from any mistletoe population without being sure that this will not threaten the viability of the source population (Norton et al. 1994). In general, much greater care will be required in the North Island, where most sources will be a small population. In contrast, some South Island areas still have abundant populations of particular mistletoes. If in doubt and the landowner is unsure, check with your local DOC office. If you know what bare seeds look like after the fruit is removed (see below) you can sometimes find these on the ground where birds have excreted them; such seeds will never establish since they did not land on a host branch, and (if fresh enough) can be moved to another site without damaging the source population.

When collecting seeds, it is important to keep good records of where the seed was collected from including information on the site locality (preferably a grid reference), the extent and condition of the mistletoe population, and the host species parasitised. When the seed is later planted out, it is again useful to keep

good records of where the seed was planted, species planted on to and number of seeds planted. Growing mistletoes is still very much a learning exercise, so the more information the better. It is often suggested that it is best not to move plants too far from where they were collected from (e.g., within the same Ecological District). This suggestion is based on concerns about local adaptation and maintenance of genetic integrity of existing populations. Planting of non-local material may result in loss of local adaptations (e.g., to particular environmental conditions) and eventually could lead to loss of overall genetic variation within a species.

Fruits of the five mistletoes start to ripen from around April onwards. This does vary depending on where in the country the different species of mistletoes are growing. Most of the fruits are gone by mid-winter, although for *P. tetrapetala* and *T. antarctica* they may remain until well into the summer. Probably the best indication of whether or not the fruits are ripe is to check their colour, shape and firmness. When ripe, the fruits should look plump and feel soft when touched. Yellow is the most common fruit colour, with the fruits of *P. colensoi*, *I. micranthus* and *A. flavida* all being different shades of yellow, although a red morph of *A. flavida* also occurs. The fruits of *T. antartica* are usually white with varying amounts of purplish flecks over them. *P. tetrapetala* fruits are very different from those of the other species because they stay green when ripe; the easiest way to tell if these are ripe is to look for a darker green ring of colour around the top of the fruit.

The fruit should come away easily from its stalk on the branch as well. There is no point picking fruits prematurely because if the fruit is not properly ripe it will be difficult to remove from its fruit skin and is less likely to germinate. Another useful way of telling if the fruits have started to ripen is to look for frugivorous birds visiting the mistletoe plant, such as tui, bellbirds, silvereyes and New Zealand pigeons (Ladley & Kelly 1996).

Selection of planting site

Once harvested the fruits should be planted as soon as possible. Although seed can be stored in a paper bag in the fridge for several days before being planted, it does appear that their viability decreases quite quickly with time so it is best to plant them as soon as possible. Our research on mistletoe-host relations shows that mistletoes establish best on the same host species they were collected from, and even within the same host species, they appear to establish best on host plants of the same provenance (source geographic region) as the host plant the mistletoe seed was collected from. This dependence on particular host species appears to be most important for the three beech mistletoes. *A. flavida* and *P. tetrapetala* are usually found growing on *Nothofagus solandri* trees, and *P. colensoi* on *Nothofagus menziesii*; while *I. micranthus* and *T. antarctica* are more eclectic in their range of host plant species, including a number of introduced ornamental trees and shrubs as well as native species. *T. antarctica* seems to do particularly well on tree lucerne (*Chamaecytisus palmensis*). A list of the known native and introduced host species was published in this Newsletter by de Lange *et al.* (1996) and is updated in de Lange & Norton (1997).

When choosing potential host plant look for appropriate planting sites. We have found that the highest success rate for establishment was obtained from planting seeds onto reasonably thin (between 3 to 5 mm thick) branches that have a thin bark layer that appeared to be actively growing. Other criteria for suitable sites include security of the site (since the mistletoes need at least 5-10 years to get large enough to reproduce); and reasonable exposure to sunlight seems to help (e.g., use the sunny side of the host, or use trees on the edge of a patch).

Planting seeds

The seed must be removed from its fruit or it will not germinate. Gently squeeze the seed out of the fruit. If the fruit is not properly ripe it will be very hard to remove the fruit skin from around it and there will be a white milky fluid around the seed. For *I. micranthus*, *T. antarctica*, *A. flavida* and *P. colensoi* the seed will pop out the hole at the bottom where the fruit had been attached to the stalk. But for *P. tetrapetala* it is easier to gently scrape the top of the fruit away (where the darker green ring is) and then to gently squeeze the seed out the top of the fruit skin; it is very hard to get *P. tetrapetala* seeds out of the hole at the bottom. Be careful with this process as the seed is soft and relatively unprotected inside the fruit. Some overseas reports on planting mistletoe seeds recommend that you cut or scratch the host branch where you plant the seed, but New Zealand evidence so far suggests that this does not give any clear benefits (our work and that of Milne 1996).

Once the seed has been removed from its fruit skin you can see a sticky cloudy gel attached to the seed, this is the layer of viscin. Viscin is a glue like substance that helps to attach the mistletoe seed to whatever it lands on. Once dry it forms a very strong bond between the seed and the host branch. Gently smear the seed on to the branch, so that the viscin makes contact with the host branch. For the seeds of *I.*

micranthus and *T. antarctica* this is particularly easy as the viscin forms a complete layer around the entire seed. The viscin on the seeds of *A. flavida*, *P. colensoi* and *P. tetrapetala* is positioned in a ring at the base of the seed. There may also be a "tail" of viscin attached to the seed, if so it is a good idea to wrap this tail around the host branch. The seed should stay on the branch after you remove your hand. If it doesn't then reposition the seed again. It may be that the viscin is too wet and not sticking on the host branch properly yet. It may help to place the seed in the junction of a side branch, or at the base of a leaf to provide extra support. We usually attach a label (a twist tie) to the branch so that the seeds can be relocated later on.

The viscin around the seed dries in a matter of hours, but seems to be able to rehydrate if it becomes wet for several days after planting. So it is a good idea not to plant seed just prior to rain, as they have a tendency to slide off the branch and be lost. Some seeds which we planted on the upper side of branches later slid around to the underside, presumably during rain. A small proportion of seeds will fall off the branches and be lost even with the most careful planting.

If you are unable to collect the ripe fruits of the mistletoe all is not lost. By carefully looking underneath the mistletoe plant you may be able to collect freshly dispersed seeds. If they are very fresh the seed will look whitish and the viscin will not have dried. After a while the seed dries and loses the whiteness and it will look green. We have had some success at gluing dispersed seeds on to host branches. We have found that Weldwood (a water based glue similar to PVA) is the best. Superglue appeared to affect the growth of the seeds. For the seeds of *A. flavida*, *P. colensoi*, and *P. tetrapetala* place a dab of the glue at the bottom of the seed (where the viscin is) and attach to the branch.

Mistletoes are primarily water parasites and utilise much more water than their hosts. Successful establishment of mistletoes in the drier areas of New Zealand (eg., eastern Canterbury) may therefore be enhanced by ensuring that the host tree is well watered.

The hard bit: waiting

Almost all live seeds germinate once the fruit skin is removed, but the length of time after planting to the first signs that the seeds have started to germinate varies for the different species. Seeds of *T. antarctica* start to germinate almost immediately after being planted, whereas the seeds of *A. flavida*, *I. micranthus*, *P. colensoi*, and *P. tetrapetala* take about four weeks. For seeds of *A. flavida*, *P. colensoi*, *P. tetrapetala* the first sign of germination is the appearance of the green root-like hypocotyl, which emerges from the top of the seed and starts to grow towards the host branch (Fig. 1). At the tip of the hypocotyl is a swollen yellow area, the holdfast, which upon contact with the host branch glues itself to the branch and attempts to connect to the hosts water conducting cells (xylem). If successful, this forms the primary haustorium, but the process takes several months during which time there is no obvious activity. The first sign of a successful connection to the host xylem is that the hypocotyl straightens, pulling the two cotyledons out of the seed case; at this stage the seed can be said to have established (see diagram). Soon after the appearance of the cotyledons the first set of tiny (about 3-5 mm long) leaves appear (Fig. 1).

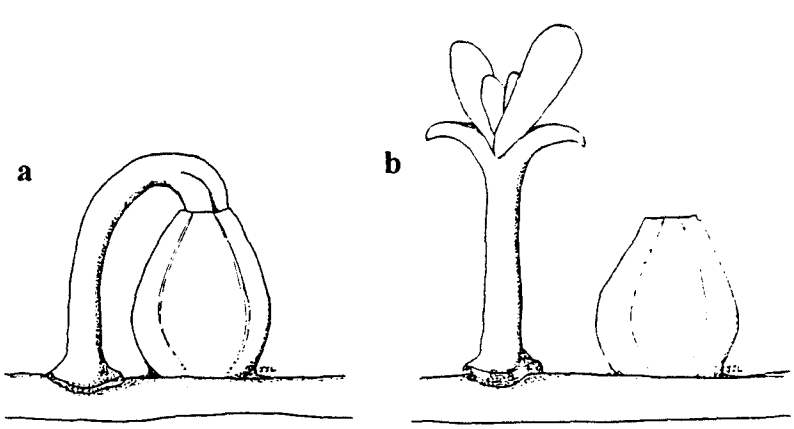

Fig. 1. (a) a germinating seed of *Peraxilla colensoi*, showing the hypocotyl growing down and attaching to the substrate. (b) A small established seedling of *P. tetrapetala* (age 10 months) showing the small leaves that are put out after establishment.

The seeds of *I. micranthus* and *T. antarctica* germinate in a slightly different manner to the other species. With *I. micranthus* seeds the hypocotyl never emerges from within the layer of dried viscin that surrounds the seed (neither do the cotyledons). On close inspection you can sometimes see the green hypocotyl growing towards the host branch underneath the seed coat. At about the same time the first tiny leaves appear out of the seed coat, indeed this can even happen before the seed has connected with its hosts xylem. For *T. antarctica* after the hypocotyl has emerged from the seed coat and grown

down towards the host branch the seedling starts to act very differently to the other mistletoe species. Once the connection to the hosts xylem has occurred the seedling seems to form a gall-like structure within the host branch and it is some time later that it starts to sprout leaves and branches (pers. comm. B. A. Fineran).

Most seeds will germinate for all the New Zealand species of mistletoe (up to 82% of those planted). However, virtually all will die before making a successful connection with the host plants xylem cells (less than 28% of those that germinated went on to establish in our trials; Ladley & Kelly 1996). Mortality appears to continue as the mistletoes grow. For example, for *Alepis flavida*, 91% germinated, 22% produced cotyledons, and 14% produced their first leaves, but only 2% went on to produce further leaves in the first year. Once established the young seedlings grow quite slowly, especially when compared to some tropical species of mistletoe that can be flowering 10 weeks after germinating (Room 1973). *Alepis flavida* appears to be the fastest growing of the beech mistletoes, with seedlings up to 30 mm long and with runners up to 50 mm long in the first year. In contrast after three years a *P. colensoi* seedling planted onto *N. menzesii* in Nelson had grown to a length of 65 mm and had 12 small leaves, and after two years a *P. tetrapetala* seedling planted on *N. solandri* on the Canterbury University campus consisted of a main stem 130 mm long with 28 leaves. Less is known about the growth rates of *Ileostylus* and *Tupeia* seedlings. However, while very little happens in the first 9-12 months after planting, growth is more rapid once good connection is made with the host xylem, and we hope that if they survive these seedlings will produce their first flowers sometime in the next three or four years.

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■ Biographical Notes (27) : Thomas George Wright (? 1831–1914)

From the 1880s to the turn of the century three amateur bryologists were active in Christchurch: Robert Brown (1824–1906), a shoemaker who had come to New Zealand in 1876 and lived in Andover Street, Merivale (1); Thomas Wrench Naylor Beckett (1839–1906), an orchardist at the corner of Clyde and Ilam Roads, Fendalton, who had been a coffee planter in Ceylon and came to New Zealand in 1883 (1); and Thomas George Wright, printer and pressman, the subject of this note.

T.G. Wright was born in Surrey, England, the son of Thomas Wright, a printer, and his wife Ann (born Folo) (2). His early life was described in the "*Christchurch Press*" as follows: "He was trained originally as a compositor in the Old Country, but afterwards joined the Navy and served on the China coast during the troubles there, and also in the Crimea, where he was present at the fall of Sebastopol [Sept. 1855]. He was attached, while on the Crimean service, to the medical stores department, and in the course of his duties he was brought into contact with Florence Nightingale. Some of his most treasured possessions were orders for stores signed by Florence Nightingale, which he had carefully preserved" (3).