Patua Te Otaota - Weed Clippings

Biological Control of Weeds Annual Review 1999/2000

What's Inside:

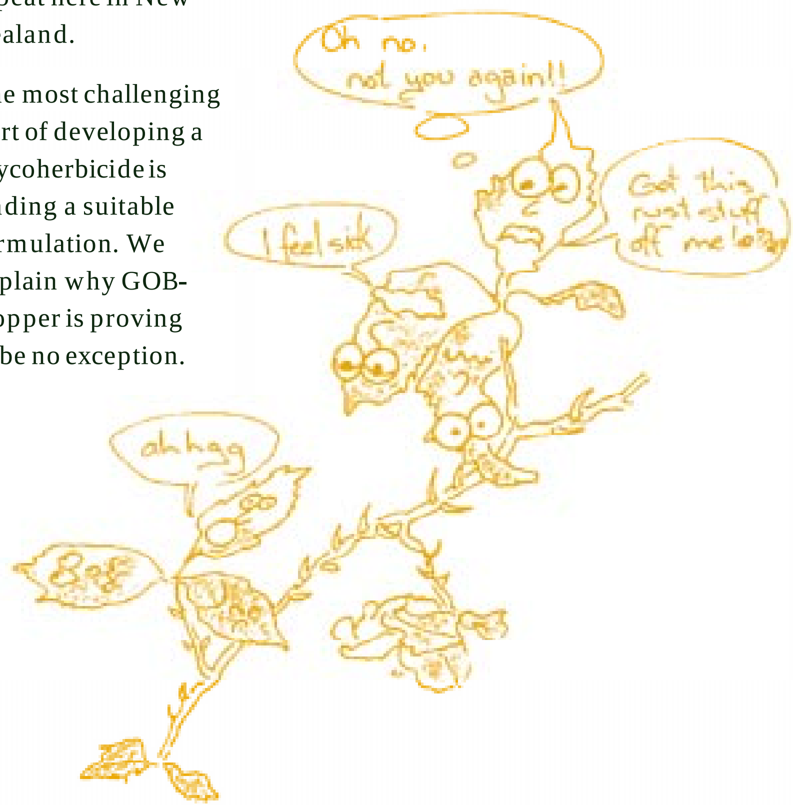
Manaaki Whenua
Landcare Research

Introduction

- Welcome to the sixth issue of *Patua Te Otaota - Weed Clippings*, which we have published to keep clients, stakeholders, and research colleagues informed about our progress in developing sustainable biological control solutions for weed problems.

Headlines

- The white smut made short work of mist flower in Hawai'i. We are optimistic that history looks set to repeat here in New Zealand.
- The most challenging part of developing a mycoherbicide is finding a suitable formulation. We explain why GOB-stopper is proving to be no exception.
- Broom psyllids seem to be a tad reluctant to explore the big wide world. We show people how they can encourage them to spread their wings.
- At present many people rely on herbicides to control broom. We look at the consequences for broom biological control agents.
- Sometimes size does matter. We reveal that the largest broom seeds are responsible for broom sweeping across the landscape, and suggest that broom seed beetles may be able to put an end to this.



- In future, gaps might begin to appear in solid blocks of gorse. We outline a possible scenario that shows how seed feeders may allow this to happen.
- Biological control agents sometimes turn up in the strangest places. We ponder why gorse pod moths were found to be hanging around an area where gorse is rare, and how old man's beard agents found their way to a lone old man's beard plant in Auckland.
- Who's who in biological control of weeds in New Zealand? We have summarised the vital statistics of the most important agents you need to know about.
- Moth plant appears to have few redeeming features, but variegated thistle might not be all bad. We debate the pros and cons of developing biological control for these targets.
- Home-grown biological agents seem to be in short supply in New Zealand. We profile the generalist creatures that include bone-seed, banana passionfruit, nassella tussock, and Chilean needle grass in their diet here.
- Hieracium gall wasp rearing has gone fantastically well, the Californian thistle project is on a roll again, heather beetles have finally turned up, and the "Biological Control of Weeds Book" is about to expand again. We bring you up to date with these projects in a series of News Flashes.

Control Agents Released in 1999/00

Species	**No. Releases Made**
Broom psyllid (*Arytainilla spartiophila*)	40
Broom seed beetle (*Bruchidius villosus*)	40
Californian thistle gall fly *(Urophora cardui)*	2*
Gorse pod moth (*Cydia succedana*)	51
Hieracium gall fly (*Aulacidea subterminalis*)	27
Mist flower fungus (*Entyloma ageratinae*)	1
Old man's beard leaf fungus (*Phoma clematidina*)	15
Old man's beard leaf miner (*Phytomyza vitalbae*)	11
Scotch thistle gall fly (*Urophora stylata*)	2
Total	**189**

*cage rearing was also undertaken

The glorious moment — Simon Fowler tracks down heather beetles at last!

History Sometimes Repeats

The mist flower fungus (*Entyloma ageratinae*) has been spreading at the rate of knots since its release last year. Our monitoring has confirmed that the fungus is well established and has spread at least 1 km from the nine release sites in Auckland, Northland, and Waikato. Through the bush telegraph (of Department of Conservation and regional council staff) we know this is just the tip of the iceberg. The smut is now so widespread in the Waitakere Ranges that no uninfected areas could be found for studies into long-term vegetation changes. Pathologist, Jane Fröhlich, made a trip to Great Barrier Island to release the smut only to find it had beaten her there. "It may have blown from the closest release site on Waiheke Island, 77 km away, but it is also possible that people might have accidentally carried it there," explained Jane. The fungus is also widespread in Northland, where it has been found about 20 km from at least two of the three release sites, and the only places where uninfected patches have been found are at Puhoi and Te Paki.

Mist flower too has the ability to spread at a phenomenal rate. This year a team has again estimated the amount of mist flower growing 5 m either side of walking tracks in the Waitakere Ranges. The area thought to be infested with mist flower had increased by a whopping 7000 m^2 in only 1 year and now totals 31 000 m^2! The results from a nationwide survey asking people where they have seen mist flower have also been collated and all known infestations mapped and their environmental characteristics compared. This exercise has revealed that the plant could theoretically occupy a much larger area of the North Island than it currently does and also the top of the South Island. It seems that we have brought in the white smut just in time!

Chris Winks knee deep in mist flower at Mt Eden before the release of the white smut and the same site just over a year later. The white smut has already knocked the mist flower hard

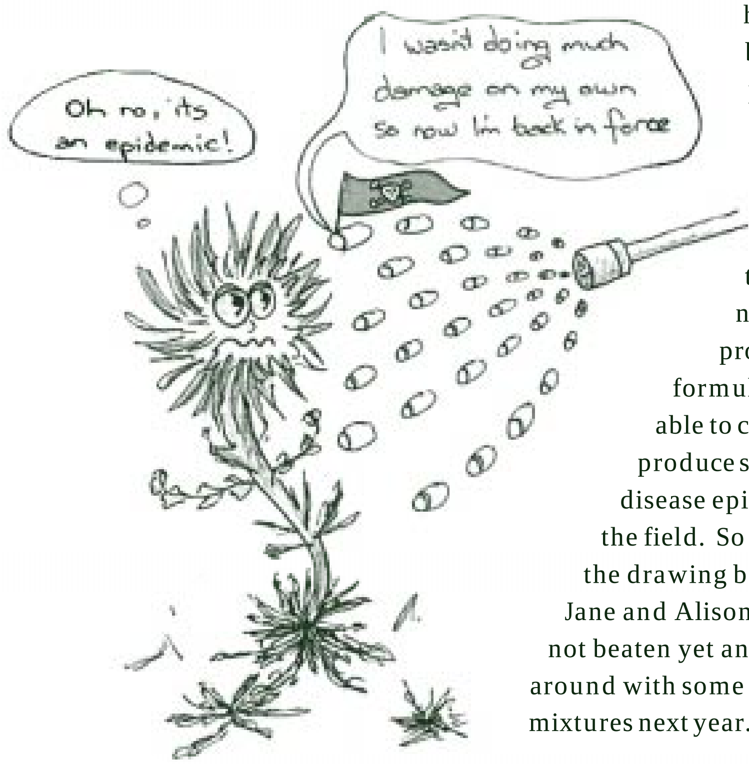
The amount of damage the smut is doing already is extremely encouraging. Our monitoring has shown that at most sites 30–50% of the mature leaves were wiped out in the first wave of attack. Although plants have tried to regrow, 40–60% of this new growth has been affected by a second wave of attack. They can expect a third onslaught this spring. Areas choked with mist flower support fewer native species and more exotic species than equivalent areas free of the weed. "The white smut has already defoliated mist flower plants at the release sites to the extent that other species (particularly native plants and ferns) have started to poke their noses through," proclaimed Alison Gianotti.

This work was funded by the Auckland Regional Council, Northland Regional Council, and the Northland Conservancy of the Department of Conservation.

Waging War on Woody Weeds

Oil and water don't mix

The idea of developing the fungus fusarium blight (*Fusarium tumidum*) into a mycoherbicide to control gorse and broom (GOB-stopper) looks great on paper but is proving quite tricky in real life. The stumbling block lies in developing a suitable formulation that keeps the fungal spores alive and kicking long enough for them to be able to infiltrate their target. The ability to develop a suitable formulation has tended to make or break potential mycoherbicides worldwide.



This year some prototype formulations were tested at a field site near Rotorua. These various mixtures of water and oil had proved their worth under laboratory trials, but unfortunately did not produce promising results in the field. "The prototype formulations were found to damage plants even when they didn't have any fusarium blight spores in them and they are supposed to be the active ingredient," bemoaned Jane Fröhlich. "This means that the formulations were toxic themselves and could also potentially harm any beneficial plants they came into contact with." To add insult to injury none of the prototype formulations was able to consistently produce severe disease epidemics in the field. So it's back to the drawing board for Jane and Alison. They are not beaten yet and will play around with some more mixtures next year.

Encouraging young psyllids to spread their wings

Although adult broom psyllids (*Arytainilla spartiophila*) can fly, they appear to be reluctant to explore the big wide world and tend to venture out from release sites extremely slowly. We have now figured out the best way that people can boost the distribution of this aphid-like agent. It is important to wait until the psyllids have built up into harvestable numbers, and this usually takes at least 4 years after they are introduced to a new area. If tens or hundreds of psyllids can be dislodged by beating broom foliage with a stick, then it is safe to begin. The best time of the year to harvest is when the juveniles (nymphs) are around (usually October–November). It is possible to shift the adults too but these are more fragile and may be too old to lay many more eggs. Infested branches can be snipped off and put into bags. Later these infested branches are wedged into new bushes so that the psyllids can move across. It may be tempting to use a garden-leaf vacuum to collect psyllids, but this is not advisable as the psyllids are fragile and easily damaged.

Warning, herbicides can be fatal!

This year the dream of developing integrated management for broom has moved a step closer to reality. "Before we could begin we needed to understand how people at the coal face are actually controlling broom at present, and we have asked many of these people, including farmers in one of the worst-infested parts of the country to share their secrets with us," explained social scientist Margaret Kilvington. North Canterbury farmers told us that by far and away their preferred method involves chemicals (92%), followed by grazing (48%), manual methods (31%), fencing (22%), pasture renewal (20%), and application of fertiliser or lime (17%), with burning the least popular (12%).

From these responses it became obvious that the most pressing issue was a much better understanding of the impact that commonly used herbicides have on biological control agents. The farmers told us that they most commonly use Grazon® (triclopyr), Tordon Brushkiller® (triclopyr and picloram), Roundup® (glyphosate), and Trounce® (glyphosate). "We were able to restrict our testing to just Tordon Brushkiller® and Roundup® as they share the same active ingredients with the other two*, "explained Pauline Syrett. "There is considerable variation in the recommended (and actual) application rates for herbicides so, as well as testing knapsack field rates, we also needed to find out what the strongest possible concentrations the broom control agents might ever come into contact with might do."

Adult broom insects were given a dose of either herbicide or water and then examined 3 days later (see table below).

Helen Harman shows how to harvest broom psyllids

Lindsay Smith reports that the three agents varied quite a lot in their susceptibility to the herbicides. Broom psyllids proved to be extremely sensitive. Even half the field rate of Tordon Brushkiller® caused them to rapidly turn up their toes, and the field rate of Roundup® wasn't much better. Broom twig miners (*Leucoptera spartifoliella*) coped reasonably well with field

** We tested Tordon Brushkiller® and Roundup® because they are most commonly used and not because Landcare Research endorses them in any way.*

Treatment		Effect after 3 days		
Chemical	**Rate ml/litre**	**Broom seed beetle**	**Broom psyllid**	**Broom twig miner**
Tordon Brushkiller®	6	-	90% dead	-
	12	All alive	All dead	10% dead
	120	50–65% dead	All dead	All dead
Roundup®	10	All alive	60% dead	All alive
	100	All alive	All dead	All alive
	300	-	90% dead	33% dead

- test not carried out

rates of Tordon Brushkiller®, but threw in the towel at 10 times the field rate. Roundup® seemed to be a lot more acceptable to the twig miners, with significant deaths only beginning to occur at 30 times the field rate. Broom seed beetles (*Bruchidius villosus*) proved to be hardiest of the lot. Field rates of both herbicides, and 10 times the field rate of Roundup® did not harm the beetles or their subsequent egg production. However, 10 times the field rate of Tordon Brushkiller® proved to be the undoing of more than half of them.

Juvenile life stages were not tested because they are not very mobile and, even if they can survive a dose of herbicide, their number is up if their food source dies. The farmers told us that they tend to spray pretty much all year round with the exception of winter. "To help people to know when it is safest for them to spray, we have prepared a life cycle chart highlighting when the adult stages are around," revealed Hugh Gourlay.

Further research is needed before the last word on broom agents and herbicides can be said. "On the whole Tordon Brushkiller® seems to be more lethal to broom agents than Roundup®, and we would like to know which of its active ingredients is responsible,"

said Pauline. If triclopyr is the culprit, then we expect Grazon® may also be damaging to the insects, but if it's picloram then Grazon® may be safe to use. Surfactants, are often thrown into the mix and the consequences of using these also needs to be assessed.

The good do not always die young

One of the sneaky tricks that makes weeds so successful is their ability to disperse over large distances. Some have developed special mechanisms ranging from hooks and fleshy fruits, to wind-borne parachutes. Broom uses explosive pods, and a recent study of its dispersal behaviour helps to explain why the plant spreads at such an alarming rate.

The Lincoln-based study found that broom plants can throw seeds to a distance of just over twice their height (e.g. a 2 m plant can throw seeds at least 4 m). The distance thrown depended on the size of the seed. Small seeds tended to fall close-by with the largest seeds travelling furthest. "We suspect that the healthiest pods explode with the greatest gusto and also produce the largest seeds," explained plant ecologist Trevor Partridge.

Sometimes size does matter, as the large seeds seemed to have several advantages over their smaller counterparts: they were more viable and also produced seedlings that were able to grow faster. "While most seeds landed close to their parent plant, the best seeds (with the best chance of producing vigorous offspring) were thrown furthest away. This is why a small clump of broom can quickly cover a whole hillside, and underlines the importance of controlling boundaries and outliers," explained Trevor.

We are hopeful that the broom seed beetle will be able to clip broom's wings. The beetle has established readily throughout New Zealand, and is already destroying as much as 80% of seed at some sites. As well as consuming the seeds, the tunnelling action of the larvae may possibly weaken the pod's explosive mechanism. If fewer seeds are produced and they fall closer to their parent plants, then broom's invasion rate could be slowed considerably.

Variety is the spice of life?

Gorse is one those plants that displays a lot of variety in its phenology (or growth cycle) throughout New Zealand. In the deep south it tends to flower once, more or less in midsummer, whereas in the far north it flowers almost all year round. However, throughout most of the country gorse tends to flower in spring and autumn. A recent study completed in the Canterbury foothills has provided some interesting insights about how this variation might affect the prospects for gorse control using seed feeders alone. Like most gorse infestations in New Zealand the gorse seed weevil (*Exapion ulicis*) was already well established at Jimmy's Knob. However, it was the first place where gorse pod moth (*Cydia succedana*) established in large numbers (they were released there in the early 1990s after it had become apparent that the seed weevil could not destroy all of the spring or any of the autumn seed crop) and provided researchers with a unique opportunity to study interactions between the two seed feeders.

About 70% of bushes flowered at Jimmy's Knob in the spring, but the sea of yellow was even more impressive in the autumn when virtually all the plants flowered. "Setting seeds, however, was a different matter, and we were surprised to find that bushes at different parts of the site behaved differently," said Trevor. "Bushes at the bottom of the hill only produced seeds in spring whereas bushes at the top of the hill only produced seeds in autumn." For some reason many plants made flowers but aborted them later. "Plants that produced a lot of seed in spring tended to do so year after year. By contrast, plants that produced seed in the autumn often seemed to take it in turns," noted Trevor. Considering that the top and bottom blocks are only 200 m apart, and differ in altitude by only 15 m, these are remarkable contrasts!

Trevor Partridge contemplates the mysteries of gorse phenology at Jimmy's Knob

The two seed feeders were found to be making big inroads into seed produced in the spring, destroying on average about 92% throughout the site. " The bushes at the bottom of the hill (that only set seed in the spring) were hardest hit losing about 96% of their seeds to the voracious grubs and caterpillars," explained Hugh Gourlay. Because most seeds were produced by only a small number of individuals, the few that did survive tended to fall in a patchy fashion. Trevor has suggested that if this trend continues, a possibly future scenario is that gaps (where no seeds fell) could appear in what is presently solid gorse. "At sites where spring seeding predominates the two seed feeders may be able to reduce the amount of gorse present." However, where autumn seeding predominates the converse may be true. At Jimmy's Knob the gorse pod moth destroyed only a small percentage of the autumn crop (7%). "If many seeds continue to fall evenly on the ground, then all existing plants could easily be replaced in future by new plants," explained Trevor.

However, it is important not to make too many sweeping generalisations at this stage. We do not know if the moth has reached its true potential at Jimmy's Knob, whether it will behave differently elsewhere, whether other gorse stands behave in the same way, or the impact that other control agents may have (e.g. heavy gorse spider mite (*Tetranychus lintearius*) attack can reduce flowering). We do know that it should be possible to find a third seed feeder that specialises in autumn-produced seed, should this prove necessary.

Strange but true

Graham White (Lincoln University) was surprised to discover large numbers of gorse pod moths in light traps he put out in the Mackenzie Basin, in an area where gorse is quite rare. We thought it highly unlikely that the moths had switched over onto another host, but for peace of mind we decided to investigate thoroughly, as we always do with these kinds of reports. Other legumes were common in the area, namely prostrate kÇwhai *(Sophora prostrata)* and a native broom (*Carmichaelia arborea*). "We had checked the safety of *Sophora* and *Carmichaelia* prior to the release of the moth so it was also a good opportunity to see whether the testing procedures had accurately predicted the moth's behaviour," said Hugh Gourlay. KÇwhai and native broom pods were collected from the area where the moths were trapped, and carefully examined for any signs of damage. "Much to our great relief there were no nasty surprises," Hugh confirmed.

The only insect found damaging a few of the kÇwhai seeds was a native moth (*Stathmopoda aposema).* We suspect that the gorse pod moths were probably blown into the area on strong wind currents and were attracted to prostrate kÇwhai in the absence of gorse. Although we think it highly unlikely that the moths are damaging prostrate kÇwhai, we will return in spring to see if they lay eggs on the flowers. The number collected by the light traps suggests that the moths are out there in huge numbers, and this could explain why they seem to be turning up in all sorts of places much faster than we expected.

These projects were funded by the Amuri Broom Action Group (through an AGMARDT grant), the Foundation for Research, Science and Technology, Landcare Research's Non-Specific Output Funding, and participants in our programme.

Dangerous Liaisons

There are not many old man's beard plants in the Auckland region. Imagine how surprised Chris Winks was when he found leaf-mining flies (*Phytomyza vitalbae*) and old man's beard fungus (*Phoma clematidina*) attacking an isolated plant in Mt Albert, but it did come in mighty handy when the Auckland-based One Network News wanted to film these agents at short notice! The nearest release sites for these agents were in the Bay of Plenty, more than 300 km away. Rapid spread is all in a day's work for many rust fungi (which have wind-blown spores), but old man's beard fungal spores are large and sticky, and are thought to spread mainly by water splash. The leaf miner has been quick to colonise, even isolated, infestations all over New Zealand, but how did the fungus find its way to this lone plant in the urban desert?

Rüdiger Wittenberg (CABI Bioscience) had previously shown that the leaf-mining flies could pick up the fungal spores from an infected agar plate and transmit them to a fresh plate. "However, it was less clear what might happen under field conditions," explained Richard Hill (Richard Hill and Associates), "so we designed some experiments to find out." We put leaf-mining flies onto seedling plants and left them to make feeding punctures in the leaves. Then we sprayed the seedlings with fungal spores to simulate infection by rain splash. However, the fungus invades directly through the surface of the leaves and the flies' feeding punctures did not appear to enhance the development of the disease.

Feeding punctures made by old man's beard leaf

"We also sprayed newly-emerged leaf miners with massive numbers of fungal spores," said Jane Fröhlich. Some of these flies were put onto clean old man's beard plants for 2 days. "Of the 14 leaves attacked by the flies, only one showed characteristic signs of infection." We can conclude that while the flies are capable of introducing the fungus into leaves (via their ovipositor or mouthparts), it probably doesn't happen often. The rest of the flies were rolled on agar plates (fiddly stuff!) at various intervals to see how long viable spores remained on them. The answer was not long, as none of the flies still carried viable spores after 24 hours.

"Leaf-mining flies do not appear to be a good vector for the fungus. The spores do not survive for any length of time on the flies, and the rate of transmission is also low," concluded Richard. The experiments suggest that leaf miners probably don't significantly increase the rate of fungal spread. The Mt Albert case may be an exception, but other explanations seem more likely. "I have quite regularly brought old man's beard samples back from release sites, and examined them in the lab," confessed Chris Winks. It is possible that some flies or spores escaped out the window, and against huge odds, found and infected the plant growing a couple of kilometres away. However, it seems most likely that the fungus is spreading naturally at an extremely fast rate.

This research was funded by the Foundation for Science, Research and Technology.

Who's Who in Biological Control of Weeds?

Alligator weed beetle (*Agasicles hygrophila*)	Foliage feeder, common, often provides excellent control on static water bodies.
Alligator weed beetle (*Disonycha argentinensis*)	Foliage feeder, released widely in the early 1980s, failed to establish.
Alligator weed moth (*Arcola malloi*)	Foliage feeder, common in some areas, can provide excellent control on static water bodies.
Blackberry Rust (*Phragmidium violaceum*)	Leaf rust fungus, self-introduced, common in areas where susceptible plants occur, can be damaging but many plants are resistant.
Broom leaf beetle (*Gonioctena olivacea*)	Foliage feeder, application to release stalled while economic data on the cost / benefits of broom and tree lucerne are collated and evaluated.
Broom psyllid (*Arytainilla spartiophila*)	Sap sucker, becoming more common, slow to disperse, impact unknown.
Broom seed beetle (*Bruchidius villosus*)	Seed feeder, becoming more common, spreading well, showing potential to destroy many seeds.
Broom twig miner (*Leucoptera spartifoliella*)	Stem miner, self-introduced, common, often causes obvious damage
Californian thistle flea beetle (*Altica carduorum*)	Foliage feeder, released widely during the early 1990s, not thought to have established.
Californian thistle gall fly (*Urophora cardui*)	Gall former, rare, impact unknown, further releases planned.
Californian thistle leaf beetle (*Lema cyanella*)	Foliage feeder, rare, no obvious impact, no further releases planned.
Gorse colonial hard shoot moth (*Pempelia genistella*)	Foliage feeder, limited releases to date, established at one site, impact unknown, further releases planned.
Gorse hard shoot moth (*Scythris grandipennis*)	Foliage feeder, failed to establish from small number released at one site, no further releases planned due to rearing difficulties.
Gorse pod moth (*Cydia succedana*)	Seed feeder, becoming more common, spreading well, showing potential to destroy seeds in spring and autumn.
Gorse seed weevil (*Exapion ulicis*)	Seed feeder, common, destroys many seeds in spring.
Gorse soft shoot moth (*Agonopterix ulicetella*)	Foliage feeder, rare, no obvious impact, no further releases planned.
Gorse spider mite (*Tetranychus lintearius*)	Sap sucker, common, often causes obvious damage.
Gorse stem miner (*Anisoplaca ptyoptera*)	Stem miner, native insect, common in the South Island, often causes obvious damage, lemon tree borer has similar impact in the North Island.
Gorse thrips (*Sericothrips staphylinus*)	Sap sucker, becoming more common, slow to disperse, impact unknown.
Hemlock moth (*Agonopterix alstromeriana*)	Foliage feeder, self-introduced, common, often causes severe damage.

Hieracium gall wasp (*Aulacidea subterminalis*) **Hieracium plume moth** (*Oxyptilus pilosellae*) **Hieracium rust** (*Puccinia hieracii* var. *piloselloidarum*)	Gall former, recently released throughout the South Island, establishment looks promising, impact unknown. Foliage feeder, only released at one site , establishment unknown, further releases will be made if rearing difficulties can be overcome. Leaf rust fungus, self-introduced?, common, may damage mouse-ear hawkweed but plants vary in susceptibility.
Heather beetle (*Lochmaea suturalis*)	Foliage feeder, released widely in Tongariro National Park, establishment looks promising, impact unknown.
Mistflower fungus (*Entyloma ageratinae*) **Mistflower gall fly** (*Procecidochares alani*)	Leaf smut, becoming common, spreading fast, often causes severe damage. Gall former, application to release currently with the Environmental Risk Management Authority.
Nodding thistle crown weevil (*Trichosirocalus horridus*) **Nodding thistle gall fly** (*Urophora solstitialis*) **Nodding thistle receptacle weevil** (*Rhinocyllus conicus*)	Root and crown feeder, becoming common on several thistles, often provides excellent control in conjunction with other nodding thistle agents. Seed feeder, becoming common, often provides excellent control in conjunction with other nodding thistle agents. Seed feeder, common on several thistles, often provides excellent control of nodding thistle in conjunction with the other nodding thistle agents.
Old man's beard leaf fungus (*Phoma clematidina*) **Old man's beard leaf miner** (*Phytomyza vitalbae*) **Old man's beard sawfly** (*Monophadnus spinolae*)	Leaf fungus, common, often causes obvious damage. Leaf miner, becoming common, impact unknown. Foliage feeder, only released at one site so far and failed to establish, further releases will be made if rearing difficulties can be overcome.
Scotch thistle gall fly (*Urophora stylata*)	Seed feeder, limited releases to date, appears to have established north of Auckland, impact unknown.
Cinnabar moth (*Tyria jacobaeae*) **Ragwort flea beetle** (*Longitarsus jacobaeae*) **Ragwort seed fly** (*Botanophila jacobaeae*)	Foliage feeder, common in some areas, often causes obvious damage. Root and crown feeder, common in most areas, often provides excellent control. Seed feeder, established in the central North Island, no significant impact.
Greater St John's wort beetle (*Chrysolina quadrigemina*) **Lesser St John's wort beetle** (*Chrysolina hyperici*) **St John's wort gall midge** (*Zeuxidiplosis giardi*)	Foliage feeder, common in some areas, not believed to be as significant as the lesser St John's wort beetle. Foliage feeder, common, often provides excellent control. Gall fomer, established in the northern South Island, often causes severe stunting.

More Millennium Bugs

This year we looked at the pros and cons of developing biological control for four more target weeds: moth plant (*Araujia sericifera*), pampas (*Cortaderia* spp.), privet (*Ligustrum* spp.), and variegated thistle (*Silybum marianum*). This information is crucial for helping everyone to decide on directions and priorities for years to come. The main findings of two of these studies are summarised below, and the others will be reported in future newsletters.

Moth plant

Moth plant, a fast-growing evergreen vine, was brought to New Zealand as an ornamental plant in the 1880s. This South American plant has clusters of small creamy flowers that set large fruits and produce many wind-borne seeds. Thanks to their silky parachutes, the seeds can blow some distance, and the plant is believed to have reached offshore islands in this way. Jack Craw (formerly of the Northland Regional Council) had this to say about the plant "...in 20 years of assessing weed impacts I have seen no species with higher environmental weed potential." The weed is now common in parts of the North Island (especially around Auckland). It can be found around the top of the South Island but is unlikely to pose a threat to the rest of the mainland because it cannot tolerate cold. Moth plant is beginning to get a bad reputation in many other countries too, including Australia, Israel, Italy, South Africa, Spain, and the USA. Moth plant belongs to the Asclepiadaceae family. About a dozen other introduced members (we don't have any native members) of this family are commonly grown in New Zealand as ornamentals. Swan plant, widely cultivated for monarch butterflies, is the most familiar of these. "Monarch butterflies rarely lay eggs on moth plant but the caterpillars will feed on it if put on the plant," explained Chris Winks. "However, an encounter with the plant can also prove fatal for monarch butterflies (and other butterflies, moths, and bees) as their mouthparts can become trapped in the flowers." This is how the plant gets its common name, and other variations such as cruel plant.

Monarch butterfly meets an untimely end at the hands of moth plant

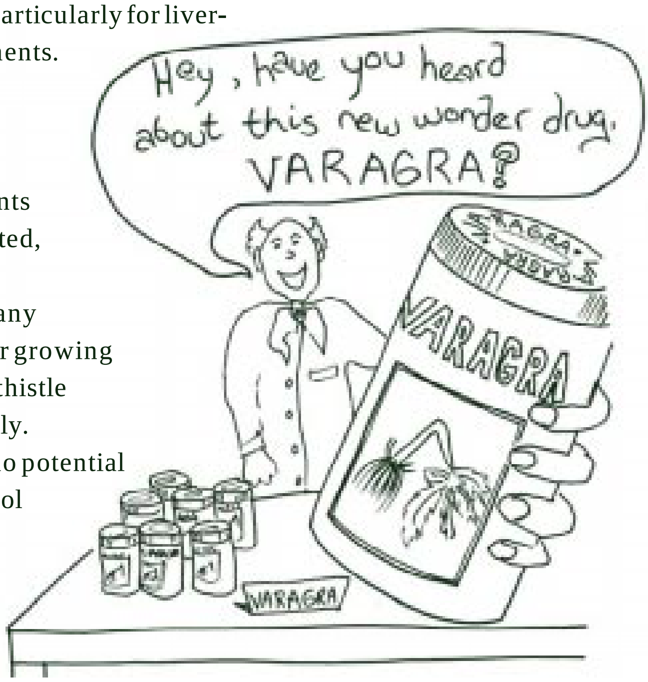
Although no biological control programmes have been undertaken against this target anywhere in the world, something is known about its natural enemies. A fruit weevil (*Rhyssomatus diversicollis*), which can damage the plant quite heavily, is one such natural enemy. The araujia mosaic virus (AjMV), which commonly stunts the plant in northern Argentina, is another. "The viral disease is transmitted from plant to plant by aphids and one of these (*Aphis nerii*) has already found its way onto moth plant in New Zealand," revealed Chris. While on the plus side we may already have a suitable vector, on the minus side viruses have rarely been contemplated as biological control agents for weeds and there is a lot we need to learn about them.

We are more experienced at working with other pathogens, like fungi. *Araujia* species in South America are susceptible to two rust fungi (*Aecidium asclepiadinum*, and *Puccinia araujae*) and it may be possible (although expensive) to develop one of these as a mycoherbicide. In fact this technique (using a mycoherbicide known as DeVine®) has successfully controlled another weedy member of the Asclepiadaceae family, strangle vine (*Morrenia odorata*), in Florida, USA.
It should also be possible to find other natural enemies by thoroughly surveying moth plant's native range. The cost of developing a biological control programme, virtually from scratch, is likely to be high, but it may be possible to reduce costs by collaborating with other countries.

Variegated thistle
Variegated thistle has spread far beyond its native range in the Mediterranean, south-western Europe, and northern Africa, to become a weed in many faraway lands including Argentina, Australia, Chile, South Africa, and the USA. Variegated thistle was first recorded in New Zealand in 1869 and is now common throughout most of the country. By thistle standards it is a large plant, growing up to 2–3 m tall and reaching 1.5 m in diameter. The size of the plant (and its vicious spines) reduces the amount of pasture available for livestock and obstructs their movement, while at the same time harbouring vermin like rabbits.

However, variegated thistle does appear to have some redeeming features. Peter McGregor's research has revealed that the plant is eaten as a vegetable in some countries and Crop and Food Research are investigating its potential as a crop grown for medicinal purposes. Commonly referred to as milk thistle, the plant has been used as a herbal remedy for centuries, particularly for liver-related ailments.

If insect biological control agents were imported, they could jeopardise any potential for growing variegated thistle commercially. However, no potential insect control agents are known at present. The nodding thistle receptacle weevil (*Rhinocyllus conicus*) sometimes attacks the plant but not enough to provide significant control. "A mycoherbicide would be the way to go as it would allow you to control the plant in some areas and not in others," said Peter. Several fungi that might attack variegated thistle are already known in New Zealand. Top priority would be *Sclerotinia sclerotiorum*, which has been developed as a mycoherbicide to a near-commercial stage by AgResearch for other thistles. Another fungus that attacks a range of thistles (*Phoma* sp.) is also already present in New Zealand and is being investigated by HortResearch. If these two prove unsuitable, then there are still at least 10 other fungi known from variegated thistle overseas that could be considered.



These feasibility studies were funded by Auckland, Hawke's Bay, Northland, and Wellington regional councils, horizons.mw, and Tasman District Council. Copies of these and earlier feasibility studies are available from Lynley Hayes (see back page).

Home-grown Heroes in Short Supply

Last year’s feasibility studies created much interest and many people were keen to implement some of the recommendations as soon as possible. Generally the first priority was to check that no useful natural enemies had already quietly turned up unannounced. Apart from looking awfully silly, we could go to a lot of needless expense if we imported something that was already here. We also needed to know what native or generalist insects or diseases attack weeds before we could decide what other natural enemies might work in best with them. With these aims in mind, four surveys were undertaken this year.

Bone-seed
None of the agents that have recently been released to attack bone-seed in Australia were found here. Fortunately we also still seem to be free of the closely related (and equally troublesome) lookalike plant, bitou bush. Bone-seed leaves often have large chunks out of them and a weevil (*Phlyctinus callosus*) is usually the culprit. “The garden weevil attacks a lot of different plants and is an important pest of grapes in its homeland, South Africa,” reports Chris Winks. Another weevil with a wide host range, the Fuller’s rose weevil (*Asynonychus cervinus*), has a taste for bone-seed too. Lots of fungal diseases were isolated from bone-seed plants, but none of them appear to have obvious potential as biological control agents.


Bone-seed damaged by the garden

Banana passionfruit
None of the agents that have recently been released to attack banana passionfruit in Hawai’i were found here. Huge numbers of the passionvine hopper (*Scolypopa australis*) are commonly seen sucking banana passionfruit (and bone-seed) sap, except on southern infestations. Another Australian immigrant, the green looper caterpillar (*Chrysodeixis eriosoma*), often chews the leaves, but is another jack of all trades. A survey to check for pathogens is planned for next year.

Nassella tussock and Chilean needle grass
In New Zealand nassella tussock (and its close relative Chilean needle grass) seem to be disgustingly healthy. “Although I managed to isolate a huge number of pathogens from these plants, they were mostly just the sorts of secondary infections that you often isolate and there was nothing to write home about,” said Jane Fröhlich. By comparison Australian researchers recently found two quite useful fungi (*Zinzipegasa argentinensis*, and *Fusarium* sp.) damaging nassella tussock there, so it does pay to do your homework.

These surveys were funded by Auckland, Hawke’s Bay, Northland, and Wellington regional councils; Environments Bay of Plenty, Canterbury, and Waikato; horizons.mw; and Gisborne, Marlborough, and Tasman district councils.
Reports on the outcomes, containing a full account of all the insects and pathogens, are available from Lynley Hayes (see back page).

News Flashes

Go girls!

Mass rearing of the hieracium gall wasp (*Aulacidea subterminalis*) went extraordinarily well this year, enabling us to release this new agent at 27 sites just before Christmas. The supreme fund-raising efforts of the Hieracium Control Trust are beginning to pay off as the wasps have now been released in all the worst-affected areas of the South Island. The wasp damages the stolons (the long runners the plant uses to make new plants). This species is parthenogenic (able to reproduce without fertilisation) so all the wasps are female and able to lay eggs. Establishment looks promising as galls have been seen in the field at two sites already.

Californian thistle commands attention

This year we confirmed what we had suspected for sometime: the Californian thistle leaf beetle (*Lema cyanella*) has established poorly, and the Californian thistle flea beetle *(Altica carduorum)* does not appear to have established at all. The Californian thistle gall fly (*Urophora cardui*) has had a significant impact on the plant overseas, but hasn't really had much of a chance to get going here. The Californian Thistle Action Group have set about remedying this by rearing the flies in special cages outdoors. This rearing was successful, and we hope that it can continue for a number of years until the distinctive galls become a regular feature on Californian thistles nationwide. By that time, hopefully, we will have some new agents to work alongside them. The group is also contributing to surveys in eastern Europe and western Asia to look for new agents, particularly stem- and root-boring insects that may damage the plant sufficiently on their own or work well with pathogens. A pathogen with the ability to severely damage Californian thistle has recently turned up in New Zealand (*Phoma* sp.), and Adrian Spiers (HortResearch) is evaluating its potential.

Left: Mouse-ear hawkweed producing healthy stolons.
Right: Stolon growth is severly retarded after attack by the hieracium wasp

Heather beetle's finest hour

Last year we reported that, despite intensive searching in the Tongariro National Park, we had been unable to find any sign that the heather beetle (*Lochmaea suturalis*) had survived, apart from a couple of dead bodies. But this year we have better news! Simon Fowler and Paul Peterson found the brownish-coloured adults and the greyish-white larvae at one of the earliest release sites (January 1996) just before Christmas. "We are amazed that the beetles managed to survive at this site, which received a liberal coating of ash when Mt Ruapehu erupted soon after the release," said Simon. As the old saying goes: "where there's smoke there's fire", so we are now confident that more beetles will be found on future visits to the park.

"The Biological Control of Weeds Book" expands

"The Biological Control of Weeds Book" is about to get fatter as we have produced another batch of pages including material for the "Basics" section on assessment techniques, new sections on alligator weed and Californian thistle, plus information on heather beetle, how to harvest broom psyllids, and how to safely use ragwort flea beetles and herbicides together. To help everyone keep track of all these pages, a revised index has also been prepared.

Further Reading

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Ireson, J. E.; Gourlay, A. H.; Kwong, R. M.; Holloway, R. J.; Chatterton, W. S. 1999. **Progress on the rearing, release and establishment of the gorse spider mite, *Tetranychus lintearius* Dufour, for the biological control of gorse in Australia.** Proceedings of the 12th Australasian Weeds Conference, Hobart, Tasmania, Australia, 12–16 September 1999: 320–324.

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Syrett, P.; Smith, L. A.; Grosskopf, G.; Meurk, C. (1999). **Predicted contributions of a plume moth and a gall wasp to biological control of hawkweeds in New Zealand.** Proceedings of the 7th Australian Conference on Grassland Invertebrate Ecology, Perth, Western Australia, 27 September–1 October 1999: 219–226

What's New In Biological Control Of Weeds? (issues 1–15) are available from Lynley Hayes (address below).

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Published By:
Landcare Research
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PO Box 69, Lincoln

Email: surname+inital@landcare.cri.nz
Web: http://www.landcare.cri.nz

ISSN 1173-6356