What's New In Biological Control Of Weeds?

Annual Review

What's Inside:

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Manaaki Whenua
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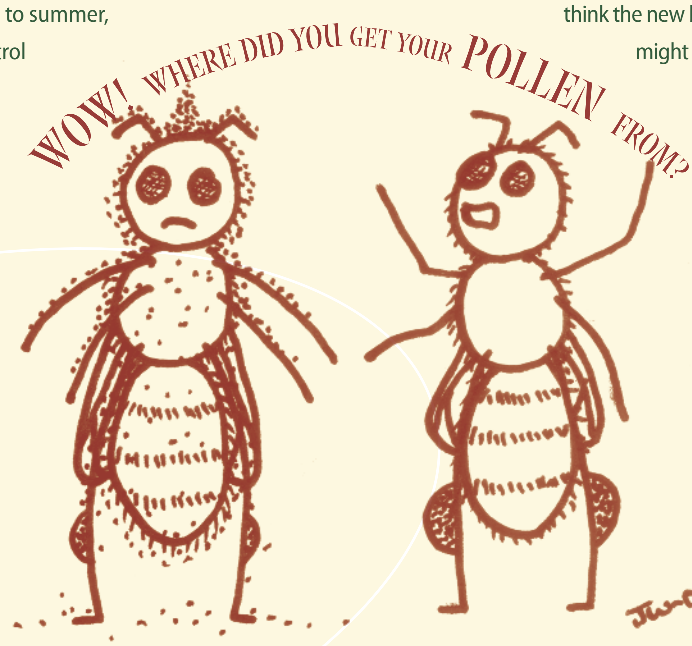
Introduction

Welcome to the third Annual Review edition of *What's New in Biological Control of Weeds?*, which we produce annually to help you keep your finger on the pulse of biological control of weeds projects in New Zealand. We report on important happenings that have occurred over the past year.

Headlines

- Could successful biological control of broom cause honeybees to go hungry in the spring? Find out about our study to investigate this claim and what bees really do get up to in the spring.
- Biocontrol of weeds has a good safety record and we want to keep it that way. Check out the latest instalment on our work to improve our understanding of how safety testing results compare with host range in the field.
- Traditionally biocontrol of weeds has relied on using insects but increasingly pathogens are also being investigated and used. Reflect on some of the challenges involved when attempting to use micro-organisms to successfully knock back weeds.
- While many of us were bemoaning the dreadful start to summer, some biocontrol agents were making the most of the wetter than usual conditions. Read about how the extra rainfall may have been just the break the hieracium programme needed.
- Finding the money to pay for biological control programmes is always a challenge. Get up to speed on the outcomes of the latest round of funding decisions.
- The fewer agents the better is our philosophy, but sometimes we have to resort to reinforcements. Discover what the last stubborn areas of ragwort may soon be up against.
- Given the wide range of climatic conditions we have in this country it is always hard to predict how biocontrol agents might fare. See how researchers think the new buddleia weevil might go.



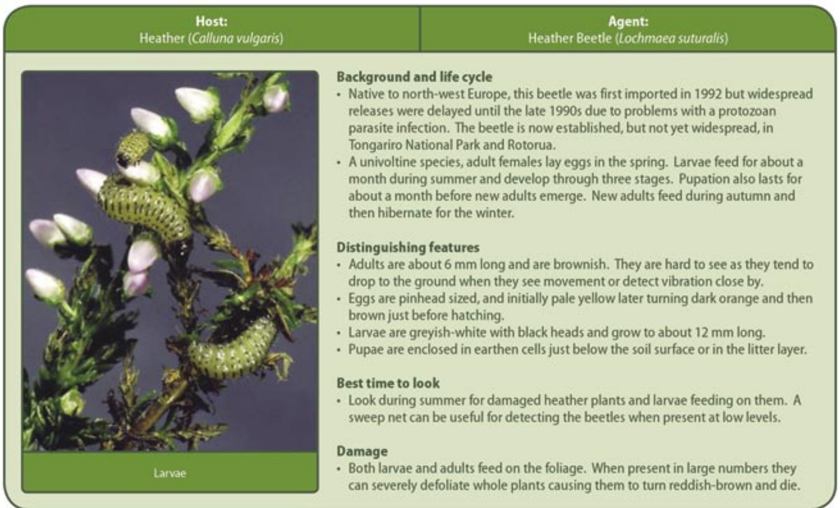
- Spring can be the busiest time of the biocontrol of weeds year, so remind yourself of some of the activities you might need to be planning for.

- Finally check out our summary of where all our weed biocontrol agents are now at, plus some tips for further reading.

Control agents released in 2004/05

Species	Releases made
Gorse colonial hard shoot moth (*Pempelia genistella*)	7
Gorse thrips (*Sericothrips staphylinus*), Portuguese strain	10
Hieracium gall wasp (*Aulacidea subterminalis*)	16
Hieracium gall midge (*Macrolabis pilosellae*)	49
Hieracium root hover fly (*Cheilosia urbana*)	5
Scotch thistle gall fly (*Urophora stylata*)	4
Total	**91**

Field Guide


Host: Heather (*Calluna vulgaris*)

Agent: Heather Beetle (*Lochmaea suturalis*)

Larvae

Background and life cycle
- Native to north-west Europe, this beetle was first imported in 1992 but widespread releases were delayed until the late 1990s due to problems with a protozoan parasite infection. The beetle is now established, but not yet widespread, in Tongariro National Park and Rotorua.
- A univoltine species, adult females lay eggs in the spring. Larvae feed for about a month during summer and develop through three stages. Pupation also lasts for about a month before new adults emerge. New adults feed during autumn and then hibernate for the winter.

Distinguishing features
- Adults are about 6 mm long and are brownish. They are hard to see as they tend to drop to the ground when they see movement or detect vibration close by.
- Eggs are pinhead sized, and initially pale yellow later turning dark orange and then brown just before hatching.
- Larvae are greyish-white with black heads and grow to about 12 mm long.
- Pupae are enclosed in earthen cells just below the soil surface or in the litter layer.

Best time to look
- Look during summer for damaged heather plants and larvae feeding on them. A sweep net can be useful for detecting the beetles when present at low levels.

Damage
- Both larvae and adults feed on the foliage. When present in large numbers they can severely defoliate whole plants causing them to turn reddish-brown and die.

Front cover and a sample page showing the layout.

This year with support from the Forest Health Research Collaborative we have been able to prepare a field guide for weed biocontrol agents in New Zealand. Unlike *The Biological Control of Weeds Book* this field guide is designed to be small enough and durable enough to be used outdoors. *Biological Control Agents for Weeds in New Zealand: A Field Guide* explains how to find and recognise biocontrol agents that have been deliberately and successfully introduced to attack weeds in New Zealand. The most significant of the self-introduced and native species that commonly attack weeds in New Zealand are also covered. Species currently under development are not included but we hope to produce additional pages for them in the future. The guide also alerts people to some of the species that are most commonly confused with biocontrol agents, because they look a lot like them, or damage other plant species in a similar way. Tips on how best to enhance agent coverage are also given.

The printing and compilation of the field guide is being funded by a national collective of regional councils and the Department of Conservation. The guide will be distributed in August to all those who have provided support for it. Others wishing to obtain a copy should contact Lynley Hayes (hayesl@landcareresearch.co.nz, ph 03 325 6701 ext 3808).

The Broom and the Bees

Could successful biological control of broom (*Cytisus scoparius*) cause honeybees to go hungry in the spring? Beekeepers raised this concern when a recent cost–benefit analysis of broom biocontrol was being prepared. Beekeepers value broom as an early-season source of pollen, and have predicted that if broom was reduced by only 25% it would still be a major cost to their industry. Few hard data are available to help uncover the truth of this claim so we have initiated a study to see what bees really get up to.

Broom flowers are cunningly designed so that not just anyone can get access to the pollen – at least not initially. "The flowers are fused shut and require an insect to force open the petals and trigger the anthers (which carry the pollen) to pop up," explained Quentin Paynter. Insects such as honeybees and bumblebees are just the right size to do this. To find out how many broom flowers honeybees visited, and whether they triggered the flowers, we followed individual bees around – some were very active and difficult to follow for long! We also chased around after bumblebees and native bees too. To check how much broom pollen the honeybees collected we set up pollen traps at the entrance to their hives.

We found that honeybees tripped the most flowers and bumblebees tripped the rest – native insects did not trip any. Flower tripping rates varied between sites, e.g. only around 20–25% at Hanmer and Palmerston North, but up to 87% at Lincoln. Therefore, the impact of a reduction in broom is likely to be quite variable. "At Hanmer where there is a huge amount of broom and only a few flowers were tripped, even a major reduction in broom may have no impact on bees. However, the small broom patch at Lincoln was heavily utilised by honeybees, so even a minor reduction in flowering might impact on them," said Quentin. However, honeybees also foraged on previously tripped flowers, which suggests that the first visitor may not clean out all the pollen in one fell swoop. So even at Lincoln, the impact may be reduced if honeybees can compensate by gleaning pollen more efficiently from already tripped flowers.

Our experiments provided strong evidence that broom seed production is pollinator-limited, as only about 2% of untripped flowers produced seed, compared to 20–30% of tripped flowers. At Palmerston North, where flower tripping rates were low, we found that if we hand-pollinated flowers we increased the proportion of flowers that produced pods from under 7% to over 30%. By contrast, at Lincoln, hand pollination resulted in only a minor (around 10%) increase in pod production. "It is amazing to think that broom might not be weedy in New Zealand at all, were it not for introduced honeybees and bumblebees!" exclaimed Quentin.

Given that honeybees appear to be contributing to a serious weed invasion, the potential costs to beekeepers should not rule out attempting to improve biocontrol of broom for the greater good. "Successful biocontrol of broom will take decades and there is an opportunity to identify what plant species are likely to replace broom and if need be encourage the planting of alternative, and preferably native, pollen sources nearby," concluded Quent.

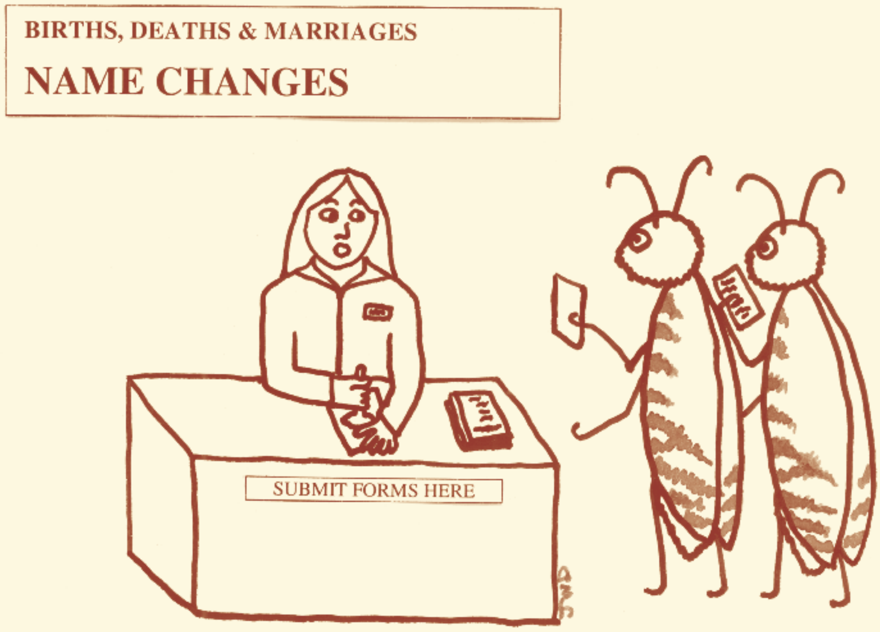
This study was funded by the Foundation for Research, Science and Technology.

Tripped and untripped flowers.

Bee tripping flower.

Making Sense of Field Findings

Previously we have told you about our surveys to check that weed biocontrol agents are behaving themselves out there and are not getting up to any funny business (see *Staying on Target*, Issue 29). This work is also helping us to improve our ability to predict the likelihood of non-target impacts, so we are better able to assess risk when making decisions about the suitability of any new agents. We have now looked in detail at the specificity of 20 well-established insect and mite agents, and four fungal pathogens. In this story we tell you about further detective work we have been undertaking with three insect species this year; we will provide a report on the pathogen side of things in a future issue.



Our non-target surveys have proven to be a major undertaking, and sometimes it has been difficult to just track down the plants we want to look at. For example we wanted to check that *Hypericum gramineum* wasn't being harmed by St John's wort beetles (*Chrysolina* spp.). This native plant was not included in host testing undertaken decades ago and has been subjected to spillover attack in Australia. *H. gramineum* is a rare plant here so it has taken us a while to find it. However, we can now report that we didn't find any evidence that St John's wort beetles are harming this close relative of St John's wort (*Hypericum perforatum*), but it may be that like us the beetles don't encounter it very often.

Some of the earlier field surveys revealed the gorse pod moth is attacking Scotch broom (*Cytisus scoparius*), Spanish broom (*Spartium junceum*), Montpellier broom (*Genista monspessulana*), tree lupin (*Lupinus arboreus*), Russell lupin (*Lupinus polyphyllus*), and lotus (*Lotus pedunculatus*), as well as gorse (*Ulex europaeus*). "Although the level of attack varies between sites, overall it appears to be quite low and probably of no major consequence to these exotic species (see table)", reported Toni Withers, who has been helping us with this work. Unfortunately gorse pod moths are not really hammering gorse either, particularly in the North Island, and the reasons for this are not yet known.

Unexpected non-target attack by the gorse pod moth has had researchers scratching their heads

Unexpected non-target attack by the gorse pod moth has had researchers scratching their heads, and the reasons for it appear to be complex. One line of enquiry being followed involves looking more closely at the taxonomies of the moth and gorse. The source of the moths used for host-testing, which suggested they were specific to gorse, was Yately Common in the UK. Moths from this area were subsequently imported and released in New Zealand. Later some moths were also sourced from Portugal in an attempt to increase genetic diversity and improve climate matching.

Some taxonomists have recently split the pod moth into two species: *Cydia succedana* and *C. ulicetana*. "However, insect identity specialists are not in agreement about this, although they do seem to agree that the taxonomy of the '*succedana* group' is complex," confided Quentin Paynter. Our best advice at the moment is that the English pod moths are now considered to be *C. ulicetana*, but we do not know yet the identity of the moths in Portugal. All the moths we have looked at in New Zealand appear to be *C. ulicetana*. Also there does not appear to be any difference between moths collected from gorse and those from non-target species, so obvious taxonomic differences do not appear to explain the non-target attack. Quentin and Shane Hona have recently been to Europe and collected moths from the two original sources and shipped them back to New Zealand. "These new collections will allow us to check the identity of the Portuguese moths and run host specificity tests to see if there is any difference in behaviour between them and their English counterparts," explained Quent.

Quentin also discovered that the gorse in Portugal is a different subspecies – *Ulex*

Shane Hona checking Clematis *during the non-target survey.*

europaeus latebracteatus as opposed to *Ulex europaeus europaeus* in the UK, so we will be following up on the implications of this too.

Field surveys have also occasionally turned up some non-target damage caused by the old man's beard leaf miner (*Phytomyza vitalbae*). Both choice and no-choice tests indicated that the flies could complete their development on several native *Clematis* species. However, the numbers of flies reared through to adulthood was extremely low, except on *C. foetida*, from which there was, in choice tests, an attack rate that was about 6% of that recorded on old man's beard (*Clematis vitalba*). Other tests showed that adult female leaf miners had poor survival and their ovaries did not develop properly unless they had first fed on old man's beard. So it was predicted that some minor spillover might occur if old man's beard and native *Clematis* species, mainly *C. foetida*, were growing in close proximity. This was at the time considered to be an acceptable risk, given the serious problem posed by old man's beard in many areas, and so permission to release the leaf miner was granted.

In the field, following extensive surveys, non-target attack has been found occasionally on *C. foetida* and twice on *C. forsteri*, but not on any other species. This year we looked to see if, as predicted, proximity to old man's beard was playing a role in the levels of attack recorded on *C. foetida*. In the North Island there were low levels of spillover at two sites where old mans' beard and *C. foetida* plants were close together (0–200 m apart) but not at another four sites when they were more widely separated (6–50 km). In the South Island the results were less clear-cut. "It was difficult at some sites to gauge with any degree of certainty that old man's beard wasn't lurking unseen nearby and confounding our results," confided Julia Wilson-Davey. The greatest degree of separation that could be found between native *Clematis* and old man's beard in the South Island was only about 10 km, which may not have been enough to separate out impacts for such mobile little critters (old man's beard leaf miner still holds our dispersal record managing to get almost everywhere in 2 years).

Again non-target damage was not routinely found at all *C. foetida* sites, and where there was damage the levels were low, usually 10% or less than levels of infestation recorded on old man's beard. A native leaf miner (*Phytomyza clematadi*) commonly mines native *Clematis* (and occasionally old man's beard) and causes similar damage, so that adult flies must be reared through to tell them apart. The vast majority of flies reared from native *Clematis* during this study were the native one. "It appears that any spillover attack by the old man's beard leaf miner is therefore inconsequential compared with damage already caused by the native species," concluded Quent.

Average annual gorse pod moth infestation rates (% of pods attacked)

Host	South Island	North Island
Gorse	16	0.4
Broom	1.1	2.6
Montpellier broom	1.0	-
Tree lupin	2.7	2.1
Russell lupin	0.8	-
Lotus	2.0	0.16

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

Toni Withers is with Ensis, a joint venture between CSIRO in Australia and Scion (the new trading name of the New Zealand Forest Research Institute Ltd).

Pitfalls, Parables and Prospects with Pathogens

Regular readers of this newsletter will be well aware that the path of a biological control project seldom runs smoothly. Biocontrol using pathogens (parasitic, often microscopic organisms that cause disease) shares many pitfalls with biocontrol using invertebrates (insects, mites etc.), but there are also some extra challenges unique to micro-organisms (viruses, bacteria, protozoa, oomycetes, nematodes and fungi).

There are two ways you can use pathogens to control weeds. A classical strategy involves simply reuniting a weed with an old enemy from which it has escaped (like we do with insect agents). An inundative strategy involves taking a microbe, bulking it up and then applying the resulting bioherbicide/mycoherbicide as if it were a herbicide. To date only fungi have been introduced for classical biocontrol, while fungi, bacteria and oomycetes have all been used as bioherbicides.

Pitfalls and parables

For a plant disease to occur you need three things to be compatible: the pathogen, the host plant and the environment, and aspects of all three can cause problems for biocontrol projects. By treating past problems as 'parables' (stories told to illustrate a moral), we can hopefully learn how to avoid similar pitfalls in the future.

You know it is going to be an uphill battle if the pathogen you want to work with has a complex life-cycle that involves more than one host; low spore production; and/or, poor ability to spread. For example, phoma leaf blight (*Phoma exigua* var. *exigua*) has been investigated in New Zealand as a potential mycoherbicide to control Californian thistle (*Cirsium arvense*) in pastures (see *Thistle Hopes Blighted Again*, Issue 29). "The fungus forms spores on the leaves of infected plants in a mucus-like ooze and so both rain droplets and air movement are needed for them to disperse to a new host," explained Nick Waipara. "Field trials have shown that dispersal via this method is slow, patchy and limited, so the fungus doesn't persist on the plants it is applied to, and doesn't spread very far beyond them." **The moral of this parable: study the biology of your proposed pathogen so you can predict any problems like this early on.**

Characteristics of the host that can make biocontrol difficult include good defence mechanisms and high genetic diversity. For example, the blackberry rust fungus (*Phragmidium violaceum*) has not been as damaging to blackberry in Australia as was hoped because of the genetic variability of the host. "Blackberry" is a common name given to many different *Rubus* species that have been introduced to both Australia and New Zealand. There are many different "strains" of blackberry rust and each is specific to a different subset of Rubus species. The illegal release of one or more unstudied strain(s) of the rust in Australia made it difficult for researchers to monitor the virulent strain they had released. "The result was patchy, inconsistent biocontrol," complained Jane Barton. "Worse, there was a long delay before researchers could determine that the illegal strain was not attacking the most problematic *Rubus* species and that the approved strain was not widespread." More rust strains have been released recently to hopefully overcome this problem.

Difficulties as a result of a genetic miss-match between host and pathogen are quite a common nemesis in biocontrol, and the selection of compatible biotypes has proved to be critical to success. As soon as the target weed, blackberry, was found to be genetically variable, researchers, but probably not stakeholders, knew that much time and effort needed to go into strain selection. "Whoever illegally imported blackberry rust strains into Australia probably didn't understand they would be setting back long-term control of the weed," surmised Jane. **Moral: study the pathogen and the host, and keep stakeholders informed.**

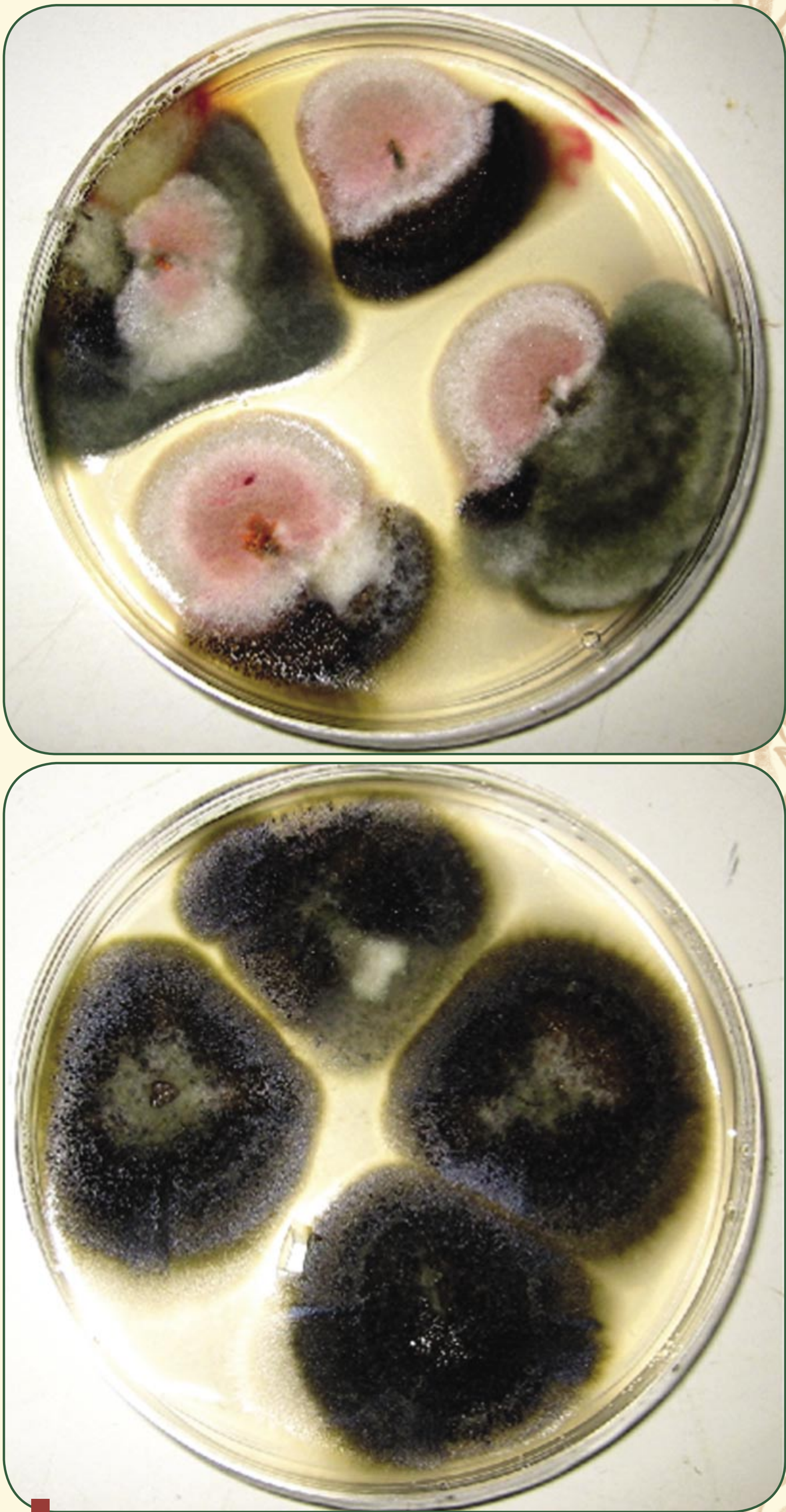
Characteristics of the environment that affect pathogens can be divided into three categories: physical, biological and human mediated. Physical environmental factors include temperature, UV radiation (which can kill spores) and moisture availability.

Californian thistle affected with phoma leaf blight.

Fusarium blight (*Fusarium tumidum*), which can kill young gorse tissues when applied as a mycoherbicide, is a good example of the latter. The fungus needs a long period of dew to successfully infect its host. Since this can't be guaranteed in the field, a lot of time and effort has gone into developing a formulation that would protect the spores from drying out, whatever the weather. Unfortunately the formulations developed to date that are best at protecting the spores contain lots of oil, which is toxic on its own to gorse, and probably also to non-target plants. "If invertebrates don't like the individual plant or environment they find themselves in or on, they can often move to a new one," said Jane wistfully. "Once a fungal spore or bacterium has landed on a host, it is stuck there and has to like it or lump it." **Moral: study the whole system (pathogen, weed and environment).**

No weed-pathogen system exists in isolation, and their interactions can be greatly influenced by the presence of other organisms in the system (i.e. biological factors). For example, other pathogens in the soil, on the plant surface, or inside the plant can limit infection through competition and antibiotic production. "There is some evidence that variable results with the old man's beard fungus (*Phoma clematidina*) in New Zealand are due to different amounts of competition on the leaf surface," confided Nick. Another important biological factor in the environment is the presence or absence of hyperparasites (parasites of parasites). It takes a lot of resources to do ecological studies, so in many cases biological environmental factors are not going to be examined until after all other possible explanations of failure have been exhausted. However, sometimes pathogen surveys done at the beginning of a classical biocontrol project can reveal that strongly competitive or hyperparasitic organisms are likely to be present. **Moral: study the whole system.**

Last, but certainly not least, human-



Old man's beard leaf fungus in culture, with (top) and without (below) competing fungi.

mediated economic/regulatory/cultural factors can contribute to the success or otherwise of plant pathogens as biocontrol agents. Economics are particularly relevant to bioherbicides. These are expensive tools to develop and register, and several fungi that have passed other hurdles have never become available, or have ceased to be available, because of a perception (accurate or not) that the market for them is too small to justify this expenditure. In New Zealand this is particularly relevant because the regulatory costs of the Hazardous Substances and New Organisms Act may be high, while the market size is small. Cultural factors come into play wherever there is a conflict of interest with respect to a target weed (i.e. where some people use or value a plant that others view as a pest). Also, while there might be potential to overcome some physical limitations of pathogens through genetic modification, that would probably be unacceptable to New Zealanders at present. Then there's the fact that many people just don't like the idea of releasing foreign pathogens in New Zealand, in case they attack non-target species. This fear is understandable, but historical data show that to-date pathogens have been very well behaved and have not unexpectedly attacked non-target plants (see *Pathological Fears Prove Unfounded*, Issue 30). This includes the regulatory authorities who make risk assessments. **Moral: Keep stakeholders informed.**

Diseased tradescantia in Curitiba, Brazil.

Prospects

After reading all this you might be wondering if we should give up on biocontrol with pathogens? The answer is NO! However, we need to pay attention to the lessons outlined above so we can get better at it. Careful studies of the biology and ecology of the pathogens, the target weeds, and the environments in which they will interact vastly improves the chances of success with pathogens. For example we are currently looking for pathogens to control tradescantia (*Tradescantia fluminensis*). We have made it a priority to work out exactly where the New Zealand populations of the weed came from, and to measure their genetic diversity. "The best chance of finding pathogens effective against New Zealand populations is to look for them in areas of South America where genetically similar plants still occur," explained Nick. Researchers are also closely studying the biology of the plant both here and in its homeland.

Likewise, the virulent pathogen white soft rot (*Sclerotinia sclerotiorum*) is being studied intensively to hopefully enable it to achieve its potential as a mycoherbicide for use on giant buttercup (*Ranunculus acris*) and Californian thistle. This pathogen has a broad host range that includes numerous crop and horticultural species. Right from the start, AgResearch scientists have been doing detailed studies of the biology and life cycle of the fungus (e.g. its survival in soil, airborne dispersal of spores). "This has allowed us to develop models for risk assessment for non-target crops that should pay dividends when it comes to registering a product (i.e. overcoming regulatory constraints)," enthused Graeme Bourdôt (AgResearch).

And of course, we try to keep our stakeholders abreast of progress with all our biocontrol projects – that's what this newsletter is all about!

This article was written by Jane Barton (a contractor to Landcare Research) based on a talk by Nick Waipara presented at a biocontrol of weeds workshop in Auckland in 2004. We thank Kim Plummer (HortResearch), Graeme Bourdôt (AgResearch), Ian Harvey (PlantWise), Adrian Spiers and the Ohinewai Farmers Group for their input.

Hieracium Agents Settle in for the Long Haul

This summer involved much to-ing and fro-ing for Lindsay Smith who liberated more of the two gall-forming hieracium biocontrol agents and assessed release sites for establishment. Happily, while the other three agents are still providing us with the odd headache, these two are getting down to business.

The hieracium gall midge (*Macrolabis pilosellae*) has been out and about for 3 years now and has established at 60% of release sites (see table). This insect seems to establish well, as galled leaves were found at 70% of sites where they were first released only a year ago. Altogether 117 gall midge releases have been made, including 49 last season. "Thanks to a bumper rearing programme I was able to double the release size of gall midges," revealed Lindsay, "and the higher numbers should increase the chances of these releases establishing."

The hieracium gall wasp (*Aulacidea subterminalis*) was first released in 1999. This year's survey showed that it has established at 20% of last year's release sites. "With the wetter than usual spring and summer the resulting lush hieracium growth hasn't made it easy to find tiny galls the size of pea!" exclaimed Lindsay. Two sites have been lost due to changes in land management, making the overall establishment success rate for all release sites to date 38%. In total, 98 gall wasp releases have been made, including four this year. All the galls found were within 50 m of the release site and at one site Lindsay found about six gall wasp larvae per square metre. Obviously higher levels than this are needed to make any impression on hieracium, but it's a start, and Lindsay hopes to be able to look into midge and wasp density and spread in more detail next year.

Five new releases of hieracium root-feeding hoverflies (*Cheilosia urbana*) were made early this year, from a shipment received from Switzerland. Unfortunately the flies emerged in dribs and drabs after a prolonged pupation period so only small numbers could be gathered together for each release. There have been nine releases of this agent made since 2002 but we are still hanging out for the first signs of establishment. Lindsay has been investigating whether the flies can be mass-reared in glass and shade houses and we will find out how successful that has been this spring. Work on the closely related crown feeding hoverfly (*C. psilophthalma*) was put on hold here this year while further research into rearing this creature is undertaken in Switzerland.

The hieracium plume moth (*Oxyptilus pilosellae*) is still proving to be a source of frustration. "I am yet to see any mating and I have worked with this insect since it was first imported in 1996!" complained Lindsay. Not even romantic music and dim lighting are working; however, we will persevere! A colleague in Switzerland, the moth's home range, has been charged with investigating the mysterious cues that trigger mating and oviposition in this pernickety insect.

This project is funded by the Hieracium Control Trust and the Sustainable Farming Fund.

Results of the 2004/05 survey

Agent	Number of releases	Sites surveyed	Sites where galls found	% establishment
Gall midge	117	62	37	60
Gall wasp	98	41	8	20

Seven chambered gall wasp gall in the field.

Paying for It

Securing funding for our research occupies many of our staff for quite considerable periods of time, so it is always great when the outcome of a competitive bidding process is positive. Late last year we were disappointed not to secure long-term (8–12 years) funding from the Foundation for Research, Science and Technology's (FRST) new Outcome-Based Investment (OBI) funding round. As a result research to advance our understanding and use of weed risk assessment was not funded. We wanted to test and refine weed risk assessment models and apply them to rank all exotic plant species in New Zealand. Alongside this, social research would have defined the role of people in the naturalisation process, and highlighted ways to mitigate the threat of new weeds. "There may now be no FRST funding available for this research for 12 years," explained Simon Fowler.

Broom leaf beetle.

However we did manage to secure funding through the smaller project round. In collaboration with AgResearch we were successful in gaining $950,000 a year for 4 years. This was less than we asked for so we have had to trim back the original proposal, guided by comments from FRST and key end-users. "Beating Environmental Weeds" now has two interacting objectives. In Objective 1 we will model the dynamics and spread of weed populations, allowing us to detect and exploit vulnerabilities in their life histories. In Objective 2 we will undertake research on weed control technologies, utilising and testing the results of the modelling in Objective 1, to improve the selection, efficacy, environmental safety and integration of biological, chemical and mechanical management methods. "The desired outcome is a leap forward in environmental weed management in New Zealand, as a result of more scientifically sound approaches than are currently practised," revealed Simon.

Two community groups (the Canterbury Broom Group and the Californian Thistle Action Group) have also recently been successful in securing funding from the MAF Sustainable Farming Fund. This means that over the next 3 years we will be able to assist them to apply for permission to release three additional biocontrol agents to strengthen the current line-up against broom (*Cytisus scoparius*): a gall-forming mite (*Aceria genistae*), a foliage-feeding beetle (*Gonioctena olivacea*) and a foliage-feeding moth (*Agonopterix assimilella*). Likewise we will also be able to complete testing of and hopefully support the release of a stem- and root-feeding weevil (*Apion onopordi*) against Californian thistle. This weevil should enhance the impact of the already widespread rust (*Puccinia punctiformis*), as well as damaging the roots and stems of thistles itself.

The National Biocontrol of Weeds Collective continues to be an important source of funding for our work. Regional councils nationwide and the Department of Conservation contribute to the collective. "Every year the collective meets to discuss progress and set priorities for the coming year, which is proving to be an effective model that benefits the country as a whole," confided Lynley Hayes. In the 2005/06 year the collective will be funding:

- Studies to find, test and/or import suitable control agents for banana passionfruit (*Passiflora* spp.), boneseed (*Chrysanthemoides monlifera monilifera*), broom, old man's beard (*Clematis vitalba*), and tradescantia (*Tradescantia fluminensis*).
- A report on the feasibility of biocontrol for Chilean flame creeper (*Tropaeolum speciosum*).
- Surveys to see what pathogens and invertebrates already occur on bridal creeper (*Asparagus asparagoides*) in New Zealand, and to look for potential agents for climbing asparagus (*A. scandens*), Darwin's barberry (*Berberis darwinii*) and moth plant (*Araujia sericifera*).
- Contributions to Australian programmes to develop biocontrol for Chilean needle grass (*Nassella neesiana*) and nassella tussock (*N. trichotoma*) and to find additional agents for alligator weed (*Alternanthera philoxeroides*).

So there's lots to be going on with!

Double Strength

An application to release two new ragwort biocontrol agents was lodged by the West Coast Ragwort Control Trust with the Environmental Risk Management Authority (ERMA) in June. "The ragwort plume moth (*Platyptilia isodactyla*) and ragwort crown-boring moth (*Cochylis atricapitana*) are European species that are being used successfully as biocontrol agents in Australia," explained Hugh Gourlay. The plume moth prefers large rosettes and they have reduced ragwort (*Senecio jacobaea*) density by 60–80% at some sites in a couple of years. The crown moth will sometimes kill ragwort plants but more commonly reduces the height of ragwort plants, the number of seeds produced, and seedling survival.

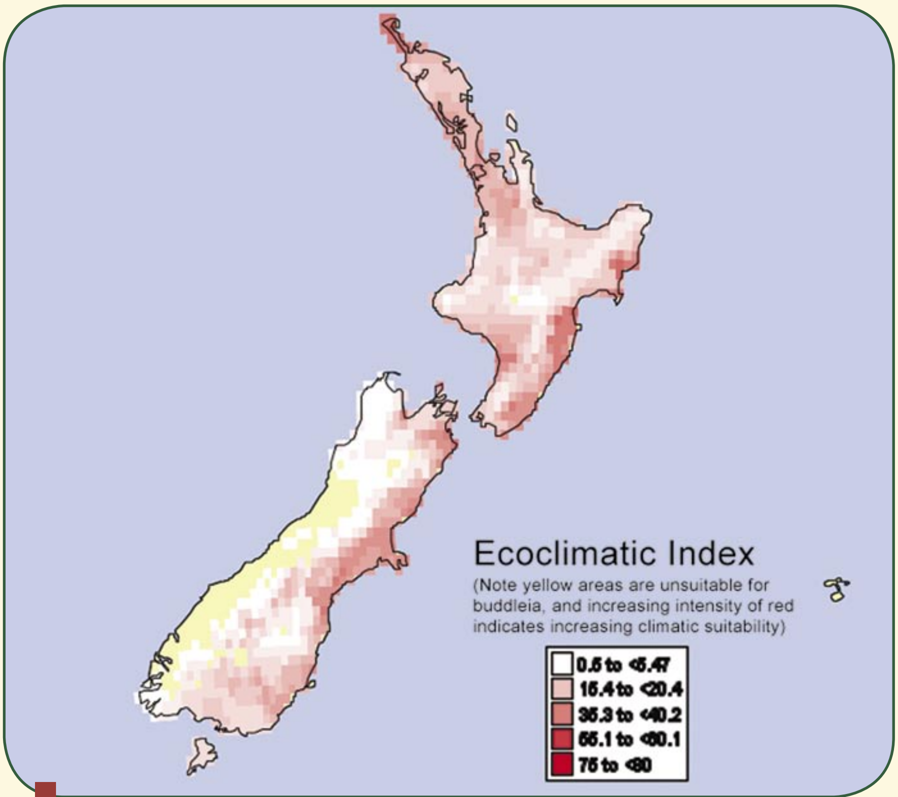
The ragwort flea beetle (*Longitarsus jacobaeae*) has brought about the demise of ragwort in most places in New Zealand where the weed is a problem. But there are still some areas where the weed has managed to persist, and so new agents are needed, e.g. coastal areas of the lower North Island, on the West Coast of the South Island, inland Canterbury, parts of South Canterbury and Otago, and throughout Southland.

"Testing has shown that the two moths are unlikely to pose any problems to populations of any plants other than ragwort," revealed Richard Hill, who helped to prepare the ERMA application. If permission to release these ragwort-feeding moths is granted it is hoped that they will be able to uproot ragwort from its final strongholds. The first releases would be made on the Coast and then the moths would be made available to other areas once numbers permit.

This West Coast Ragwort Control Trust project is funded by the MAF Sustainable Farming Fund with smaller contributions from a number of Coast-based organisations. Richard Hill is a subcontractor to Landcare Research.

Not Just a Pretty Shrub

Buddleia (*Buddleja davidii*) has become a serious weed in forests of the Central North Island and Bay of Plenty. It hinders the establishment of native and exotic trees by depriving them of light. The trouble doesn't stop there though as a potential distribution model constructed by Darren Kriticos, of Ensis, shows that buddleia could become a problem in most New Zealand forests and woodlands (see map). In a bid to curb this rampant plant, Ensis scientists are investigating a Chinese weevil (*Cleopus japonicus*), which feeds on the leaves. For the weevil to be an effective biocontrol agent, it needs to be able to complete at least one generation per year. "We know from previous developmental experiments that the weevil can cope with climatic conditions in the North Island where buddleia is currently the most problematic, but we wanted to see if it could follow buddleia into other regions too," explained Darren. The potential range of the insect has been explored using the same modelling software (CLIMEX) that predicted the spread of buddleia and it looks like the weevil would be able to complete its life cycle at all New Zealand sites thought to be climatically suitable for buddleia. However, Darren cautions that other climatic and non-climatic factors could act to limit its survival at any given location. "An application to release the weevil is currently with ERMA, and if they do give the nod then close monitoring of the weevil at relatively cold sites will provide more confidence in the results of this study," confirmed Darren.



The potential distribution of buddleia in New Zealand based on the CLIMEX Ecoclimatic Index.

Ensis is a joint venture between CSIRO in Australia and Scion (the new trading name of the New Zealand Forest Research Institute Ltd).

Spring Activities

Spring can be a busy time on the biocontrol of weeds calendar and there are quite a few activities that you might need to plan for such as:

Broom psyllids (*Arytainilla spartiophila*)

- Check release sites. You may see the pink to orangey-brown nymphs from mid–late spring, especially feeding on new growth. They feed and moult through five stages before they become brown-winged aphid-like adults. Both adults and nymphs suck sap from broom plants and produce honeydew, so you may notice plants are covered in sticky droplets and stems are blackened due to a sooty mould growing on the honeydew. Greyish, mottled foliage may also be noticeable where the psyllids have been feeding and new leaf buds may be blackened and dead. Last spring was the first time that we had a significant outbreak at Lincoln with obvious noticeable damage. We would love to hear from you if you come across an outbreak.
- Move psyllids around. Psyllids are considered to be fairly slow to disperse (hundreds of metres per year) so shifting this agent around is likely to be useful. Collect nymphs by cutting infested material and carefully putting it into paper rubbish bags. Later wedge the cut material firmly into uninfested broom bushes. Although psyllids can establish from extremely low numbers, aim to release at least several hundred. It is not ideal to shift adults as they are quite fragile and may be too old to lay many eggs.

Broom seed beetles (*Bruchidius villosus*)

- Check release sites. Look for adults in the spring congregating on broom flowers. Once pods have formed you can look for the eggs which are just visible to the naked eye as shiny oval spots, smaller than a pinhead, and are often laid close to the edge of the pod. Once they have hatched the empty cases take on a white appearance.
- Move beetles around. Although the beetles are able fliers and are dispersing steadily, it may still be useful to harvest and move them around in some areas. To do this either beat broom flowers with a stick over a sheet and suck the beetles up with a pooter, or put a large bag over flowers and give it a good shake. Shift at least several hundred. Alternatively, wait and harvest infested pods when they are mature and blackish-brown in colour and beginning to burst open.

Gorse soft shoot moth (*Agonopterix ulicetella*)

- Check release sites. Aim to visit sites in late November/early December when the caterpillars are about half-grown. Before that they are too small to easily spot, and later pupae often fall out of the webs onto the ground so they are not easy to identify at this stage either, unless the damage to new growth is so severe that it can't possibly be anything else. It would be worth checking any sites that have previously shown positive results from pheromone trapping. Look for webbed or deformed growing tips with a dark brown or greyish-green caterpillar (they change colour as they age). Leafroller caterpillars are quite common on gorse but are generally brighter green and smaller. Last year was the first time we had seen a major damaging outbreak of this agent (in Marlborough) so we would be keen to know about any other hot spots. Also just keep an eye out generally when looking at gorse at this time of the year as you may be surprised where the moths do turn up.
- Shift moths around. Although the adult moths are strong fliers they appear to disperse fairly slowly (kilometres per year) so harvesting and moving them around is likely to be useful. If caterpillars are present in good numbers harvest branches or even whole bushes. Shift at least several hundred webs to each new site and wedge them firmly into new bushes.

Gorse hard shoot moth damage

Gorse colonial hard shoot moth (*Pempelia genistella*)

- Check release sites. Look in late spring when the green-and-brown striped caterpillars and their webs are at their largest and before plants start to put on new growth. You may also notice die-off that looks similar to damage caused by the gorse stem miner (*Anisoplaca pytoptera*) or lemon tree borer (*Oemona hirta*) (see photo). We are only aware of establishment at three sites in Canterbury and would be very interested to know about the fate of others. Don't be too disappointed if you don't find anything as it may take several years before this agent becomes numerous enough to be easily detectable.
- Shift moths around. If the moths are present in harvestable numbers it would be worth helping to establish them in all areas where they are needed, as soon as possible. Harvest branches with webs in late spring when large caterpillars or pupae are present. Shift at least 50 webs to each new site and wedge them firmly in new bushes.

Hemlock moth (*Agonopterix alstromeriana*)

- Check for establishment and/or familiarise yourself with this self-introduced insect. Look in late spring and early summer for hemlock moth caterpillars and their feeding damage. Caterpillars are initially predominantly yellow with black head-capsules. As they feed and grow they become light green in colour with three dark-green longitudinal stripes. The caterpillars roll up the leaves with fine webbing to form tubes. Older caterpillars also make tubes from the flowers and developing seed heads. If disturbed, the caterpillars wriggle violently and will often abandon their leafy tubes and fall to the ground, so it is not unusual to find lots of empty tubes. A heavy attack can see large hemlock plants reduced to bare stalks.

Mist flower fungus (*Entyloma ageratina*)

- Check release sites. Look in spring as the optimum conditions for infection are warm temperatures and high humidity. The fungus causes the leaves to die and fall from the plant prematurely. Under favourable conditions the fungus also invades stem tissue and causes dieback of shoots. Plants can be heavily defoliated over wide areas. Initially plants develop lesions on the upper surfaces of leaves. The undersides of each lesion may have a powdery white appearance because large numbers of white spores have been produced there, giving rise to the common name "white smut". As the disease progresses, the lesions on the upper surfaces of the leaves coalesce and become dark brown. The fungus is already widespread so no further effort should be required to spread it around.

Field Days

If you have an impressive release site where a biocontrol agent has built up to good harvestable numbers, and may also be causing noticeable damage, it might be worth thinking about holding a field day. This event could be used to inform people about and gain support for biological control of weeds, and assist with agent dispersal, by making sure all those who turn up get some to take home. Landcare Research staff are often available to lend a hand.

Hemlock moth damage.

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.
Boneseed leaf roller (*Tortrix s.l.* sp. "chrysanthemoides")	Foliage feeder, permission to release has been granted by ERMA, first releases should be made this coming summer.
Broom psyllid (*Arytainilla spartiophila*)	Sap sucker, becoming more common, slow to disperse, two damaging outbreaks seen so far, 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, galls tend to be eaten by sheep, impact unknown.
Californian thistle leaf beetle (*Lema cyanella*)	Foliage feeder, rare, no obvious impact, no further releases planned.
Californian thistle rust (*Puccinia punctiformis*)	Systemic rust fungus, self-introduced, common, damage not usually widespread.
Echium leaf miner (*Dialectica scalariella*)	Leaf miner, self-introduced, becoming common on several *Echium* species, impact unknown.
Gorse colonial hard shoot moth (*Pempelia genistella*)	Foliage feeder, limited releases to date, established at three sites, impact unknown but obvious damage seen at one site, 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 ulicetana*)	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, was thought to be rare but an outbreak was seen in Marlborough last spring and it is becoming common in parts of Canterbury, impact unknown.
Gorse spider mite (*Tetranychus lintearius*)	Sap sucker, common, often causes obvious damage, but persistent damage limited by predation.
Gorse stem miner (*Anisoplaca pytoptera*)	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, limited in distribution as the UK strain is slow to disperse but the more recently released Portuguese strain should move faster, impact unknown.
Hemlock moth (*Agonopterix alstromeriana*)	Foliage feeder, self-introduced, common, often causes severe damage.
Hieracium crown hover fly (*Cheilosia psilophthalma*)	Crown feeder, no releases made yet, it is hoped that a rearing programme can get underway soon to enable releases to begin.
Hieracium gall midge (*Macrolabis pilosellae*)	Gall former, has recently been widely released, established but not yet common at sites in both islands, impact unknown but very damaging under laboratory conditions.

Hieracium gall wasp (*Aulacidea subterminalis*)	Gall former, has recently been widely released, established but not yet common in the South Island, impact unknown.
Hieracium plume moth (*Oxyptilus pilosellae*)	Foliage feeder, only released at one site so far, impact unknown, further releases will be made if rearing difficulties can be overcome.
Hieracium root hover fly (*Cheilosia urbana*)	Root feeder, limited releases made so far and success unknown, rearing difficulties need to be overcome to allow widespread releases to begin.
Hieracium rust (*Puccinia hieracii* var. *piloselloidarum*)	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, established at three sites there and three sites near Rotorua, severe localised damage seen already especially at Rotorua.
Mexican devil weed gall fly (*Procecidochares utilis*)	Gall former, common, initially high impact but now reduced considerably by Australian parasitic wasp.
Mist flower fungus (*Entyloma ageratinae*)	Leaf smut, common and often causes severe damage.
Mist flower gall fly (*Procecidochares alani*)	Gall former, now well established and common at many sites, impact not yet known.
Nodding thistle crown weevil (*Trichosirocalus* spp.)	Root and crown feeder, becoming common on several thistles, often provides excellent control in conjunction with other nodding thistle agents.
Nodding thistle gall fly (*Urophora solstitialis*)	Seed feeder, becoming common, often provides excellent control in conjunction with other nodding thistle agents.
Nodding thistle receptacle weevil (*Rhinocyllus conicus*)	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*)	Leaf fungus, common,sometimes causes obvious damage especially in autumn, but can exist as a symptomless endophyte.
Old man's beard leaf miner (*Phytomyza vitalbae*)	Leaf miner, common, laboratory studies suggest it is capable of stunting small plants, one severely damaging outbreak seen so far.
Old man's beard sawfly (*Monophadnus spinolae*)	Foliage feeder, limited widespread releases have been made, establishment success and impact unknown.
Phoma leaf blight (*Phoma exigua* var. *exigua*)	Leaf spot fungus, self-introduced, becoming common, can cause minor–severe damage to a range of thistles.
Scotch thistle gall fly (*Urophora stylata*)	Seed feeder, limited releases to date, appears to be establishing readily, impact unknown.
Cinnabar moth (*Tyria jacobaeae*)	Foliage feeder, common in some areas, often causes obvious damage.
Ragwort flea beetle (*Longitarsus jacobaeae*)	Root and crown feeder, common in most areas, often provides excellent control in many areas.
Ragwort seed fly (*Botanophila jacobaeae*)	Seed feeder, established in the central North Island, no significant impact.
Greater St John's wort beetle (*Chrysolina quadrigemina*)	Foliage feeder, common in some areas, not believed to be as significant as the lesser St John's wort beetle.
Lesser St John's wort beetle (*Chrysolina hyperici*)	Foliage feeder, common, often provides excellent control.
St John's wort gall midge (*Zeuxidiplosis giardi*)	Gall former, established in the northern South Island, often causes severe stunting.

Naturally occurring fungal agents under development as mycoherbicides, e.g. silver leaf fungus (*Chondrostereum purpureum*) and white soft rot (*Sclerotinia sclerotiorum*), are not included in this table.

Further Reading

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If you need assistance in locating any of the above references please contact Lynley Hayes. *What's New in Biological Control of Weeds?* issues 1–32 are available from Lynley Hayes and issues 11–32 are available from the Landcare Research website (details below).

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