What's New In Biological Control Of Weeds?

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What's Inside:

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Tradescantia Beetle Approved

Towards the end of 2008 we heard the good news that the Environmental Risk Management had approved an application submitted by the Auckland Regional Council to release the first biocontrol agent for tradescantia. A big job lies ahead for the tradescantia leaf beetle (*Neolema ogloblini*, previous referred to incorrectly as *Lema obscura)*, which is of Brazilian extraction. Tradescantia is a well-known nuisance for home gardeners but is also increasingly acknowledged as a growing threat to conservation. Studies have shown that the thick mats of tradescantia that commonly grow in bush reserves in New Zealand are preventing regeneration from occuring.

Fortunately tradescantia is a much more miserable specimen in its native range and appears to be hit hard by a wide range of natural enemies. That, combined with the lack of closely related plants in New Zealand, would appear to make tradescantia an excellent biocontrol target. The leaf beetle is the first of several natural enemies that we hope to be able to release in New Zealand. Both the adults and the larvae attack the foliage and can completely skeletonise the leaves. "We have been impressed by the damage they can do to potted plants," commented Simon Fowler.

We had hoped that releases could begin before Christmas but routine testing in preparation for release from containment showed that our colonies were infested with a gut parasite, and is proving to be a slow and tedious process to clean them up. "The only upside is that if the beetles can be so prolific with the parasite they should do even better without it," explained Lindsay Smith, who has been up to his elbows in bleach for weeks keeping everything sterile.

In January Lindsay and Quentin Paynter made another trip to Brazil to collect colonies of two more beetles, which will now be put through their paces to see if

Our new weapon against tradescantia.

they might be able to join the leaf beetle. On paper it looks like the perfect line-up with one beetle *(Lema basicostata)* able to attack the growing tips and the other *(Neolema abbreviata)* the stems, which will hopefully be all that is left of tradescantia if the leaf beetle is able to achieve its full potential.

This project is funded by the Department of Conservation, National Biocontrol Collective and the Foundation for Science, Research and Technology under the Beating Weeds programme.

New Agent Update

In the last couple of years a number of new species have been released and below we fill you in on how some of them appear to be doing.

Boneseed leafroller

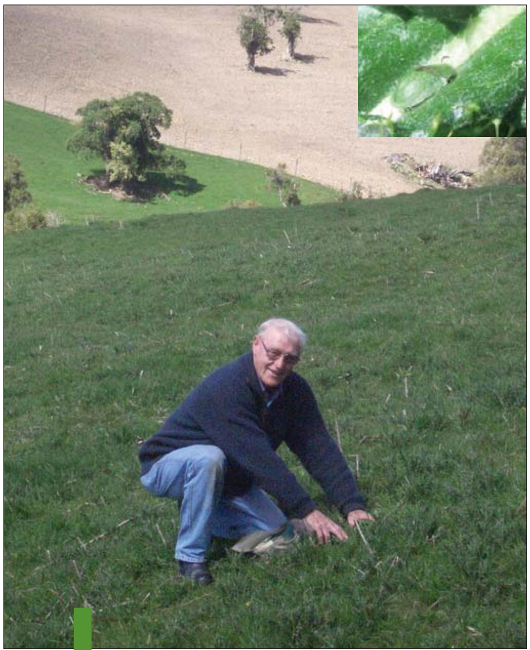
The boneseed leafroller (*Tortrix* s.l. sp. "chrysanthemoides") was released widely during spring 2007, and while many release sites are yet to be checked we can confirm that that the leafroller appears to have established at sites in Northland and Wellington. We deliberately made releases of differing sizes (50–1000) in order to gain information about the number needed to get establishment, and it was interesting to discover that the leafroller has established at two sites where only 50 larvae were released. So if the conditions are favourable it would seem that large numbers are not necessary to get establishment. However, no sign of the leafroller has been found at any of the eight sites where they have been released around Christchurch, even one where several thousand were released over a period of months. "We are a bit puzzled as the leafroller was more than happy to live and breed in our outdoor shadehouses at Lincoln," said Hugh Gourlay. Argentine ants are established in parts of Christchurch, but are not yet widespread, and are unlikely to be the reason for the leafroller's complete failure to establish on Banks Peninsula. Further research is needed to get to the bottom of this mystery before fresh efforts to establish the leafroller around Christchurch are made.

Broom gall mite

We were really excited to find evidence that the broom gall mite (*Aceria genistae*) has established at one of the earliest release sites on campus at Lincoln. "I was blown away to find a swag of galls on a plant where we had tied on a single gall in February 2008," said Hugh. Galls were found on other plants too, but some were noticeably different to those caused by the gall mite, being much harder and denser. Such galls have been seen occasionally on broom in the past but the culprit never identified, and may even be the result of a plant disease. The mite has only been released at three other sites in North Canterbury, by the Canterbury Broom Group, but widespread releases will be made available from spring 2009.

Green thistle beetle

The green thistle beetle (*Cassida rubiginosa)* was first released last summer (2007/08) by members of the Californian Thistle Action Group in Otago and Southland. Since then releases have also been made in Manawatu-Wanganui, Bay of Plenty and Waikato. A check of two of the original release sites in Southland by Peter Ayson and Jesse Bythell (contractors to Environment Southland) in November 2008 yielded good results. Damaged plants were seen at both sites and an adult beetle was found at one, which is no mean feat given how well camouflaged they are (see photo). Don Clark (Horizons Regional Council) also found damaged plants and three adults at Ohakune in January. So it looks very promising that the green thistle beetles will establish quite readily and begin to put additional pressure on a range of thistle species. Widespread releases will be offered again next spring.



Jesse Bythell

Peter Ayson recovers the first green thistle beetle from the field, who he affectionately dubbed "Hugh".

The projects to develop new agents for broom and Californian thistle have been possible thanks to support provided by the MAF Sustainable Farming Fund.

Wellington Workshop

We will run a one-day workshop at the Brentwood Hotel in Wellington on 18 June so we can share the latest results of our weeds research and possible future research directions. The workshop will be open to all interested in learning more about our work and will be free of charge. A call for registrations will be made in April and if you would like to be included in further messages about this workshop and how to register, please contact Lynley Hayes (hayesl@landcareresearch.co.nz or Ph 03 321 9694).

Can We Take the Barb out of Barberry?

Darwin's barberry *(Berberis darwinii)* was first recorded as naturalised in New Zealand in 1946. Since that time this attractive, if somewhat thorny, garden escape has managed to invade many types of habitat from grazed pasture to intact forest. Being a versatile character, Darwin's barberry can tolerate both drought and frost and grow in many types of soil. Birds and possums are attracted to the small purple berries, which are produced in abundance by this shrub, and are therefore inadvertently helping it to invade new areas.

A few years ago it became apparent that a biocontrol solution was needed and surveys to look for potential biocontrol agents have recently been completed in Chile. Sergio Rothmann (Servicio Agricola y Ganadero) helped out with the insect side of things, while Eugenio Sanfuentes Von Stowasser (University of Concepción) assisted with looking for plant diseases. "It was noticeable that Darwin's barberry is a much smaller and less conspicuous plant in its native range than we typically see here in New Zealand," said Nick Waipara, who visited Chile towards the end of 2007 and went out with Eugenio to look for diseased plants.

There were reports in the literature of potentially useful rust fungi attacking *Berberis* species. Eugenio managed to collect about 30 different types of fungi from Darwin's barberry and other closely related barberry species. At least three appear to be worthy of further study, including two rusts (*Puccinia berberidis-darwinii,* and *Puccinia meyeri-alberti).* The impact of *Puccinia meyeri-alberti* is not yet known but *Puccinia berberidis-darwinii* causes premature defoliation and leaf death. The third pathogen is still being formally identified and seems to be the most damaging one seen to date, causing shoot dieback, premature defoliation, the death of branches and potentially entire plants. Eugenio is now working to check that the pathogens he has isolated can actually infect Darwin's barberry. If they pass this test then the next step will be to undertake testing to find out their host specificity and also study their life cycles.

The insect surveys did not yield many potential candidates, but two weevils stood out as worthy of further study. The larvae of *Berberidicola exaratus* feed on the fruits and seeds, and larvae of *Anthonomus ornatus* feed on the flower buds. Given that the invasiveness of Darwin's barberry in New Zealand is believed to be due, at least in part, to its large reproductive capacity, agents that could reduce flowering and fruiting could prove useful. Hernan Norambuena (Instituto de Investigaciones Agropecuarius), whom we have collaborated with in the past against our mutual enemy gorse *(Ulex europaeus)*, has agreed to undertake host-testing of these weevils for us in Chile, and he will begin as soon as he has sourced the insects and plants he needs.

It is not yet clear just how specific agents for Darwin's barberry will need to be. We do not have any indigenous plant species closely related to Berberis, and no species considered to be economically or culturally important. However, some species of Berberis are grown for ornamental purposes, which may also potentially be invasive weeds based on overseas experience (e.g. *B. thunbergii).* *Berberis glaucocarpa* is considered to be a weed by some and a useful hedge plant by others. Other *Berberis* species are naturalised, which may prove to be problematic in the future (*B. soulieana, B. wilsoniae, B. vulgaris*), so agents with a slightly wider host range than Darwin's barberry might be preferable. We will cross this bridge once we know the likely host-ranges of the preferred agent candidates, but it is looking promising that we may indeed be able to take the barb out of Darwin's barberry in due course.

This project is funded by the National Biocontrol Collective. Nick Waipara is now with the Auckland Regional Council.

A yet to be named pathogen causing dieback.

A Shift in Thinking

For years biocontrol researchers have sought biocontrol agents with very fussy feeding habits that would preferably only attack a single weed species and not touch anything else. A problem with this approach is that we are simply not moving quickly enough to stem the ever-increasing tide of invasive plant species. The figures are quite sobering. In New Zealand it is estimated that we have at least 25,000 species of exotic plants (around 10% of the world's flora) of which around 2,200 have so far managed to naturalise, that is, achieve self-sustaining populations in the wild, at the rate of approximately one every 39 days. Currently about 500 of these naturalised species are considered to be weeds, and around 200 of them are controlled by legislation. Typically there is a time lag of several decades or even hundreds of years between a plant naturalising and becoming invasive, so it likely that we have many "sleeper weeds" that have yet to awaken and show their true colours. As if 500 species weren't more than enough to be going on with, it is inevitable that there are going to be lots more weeds to come. Although there are measures in place now to shut the door and limit the introduction of new weeds to New Zealand, the horse has largely bolted.

Given this daunting future weed scenario, the concept of using biocontrol agents with wider host ranges that could attack more than one target at the same time without compromising safety is appealing. The success of projects might also be increased if we had a wider pool of agents to choose from and no longer had to discard some promising agents because they lack sufficiently tight host specificity. It would also be more cost-effective if in the course of targeting an existing weed we could knobble sleeper weeds before they get a chance to rear their ugly heads. There might also be the added bonus of neutralising the risk of undesirable species that are not currently present in New Zealand but are widely established in neighbouring countries, and could get here by accident. It all sounds good in theory but is this multi-targeting approach really feasible and what further study might be needed before it could happen? As part of her recent PhD study Ronny Groenteman has grappled with such questions using thistles as her study system.

We know that plants are most likely to be at risk of non-target attack by biocontrol agents if they are closely related to a target weed, especially if they are in the same genus or tribe (see table for a brief outline of the hierarchical system used to classify plants). Islands like New Zealand that have been isolated from other land masses for many thousands of years often have a unique flora in which certain plant groups may be under-represented. If a genus or tribe of introduced weeds is not represented in the native flora then multi-targeting could be considered. Any closely related beneficial exotic plants still need to be taken into account as well as the possible future utilisation of plants, such as new crops, before more generalist agents could be considered. Obviously you can only do this if adequate information about the relevant plant relationships is available, and that is not yet the case for all species.

In New Zealand we have more than 100 species of introduced thistles, but only a handful of these are currently well known pests (see table). "However, from what we know about the behaviour of some of the other thistle species elsewhere in the world – which is still the best predictor of weediness – as many as 25 additional species may be sleeper weeds that could go on to cause problems for us in the future," concluded Ronny. We have no native plants in the same tribe as thistles (Cardueae) but we do have two plants that are minor crops: globe artichoke *(Cynara scolymus)* and safflower *(Carthamus tinctoria)*; one weed, variegated thistle *(Silybum marianum)*, that could potentially be used as crop; and ornamental globe thistles (*Echinops* spp.) in the tribe that need to be considered. So thistles would appear to be a group for which a multi-targeting approach should be explored further. When insects are able to utilise a number of plant species they will still have their favourites. For multi-targeting to be successful the biocontrol agents used would need to be able to suppress all the species targeted and not just these most preferred hosts. For example it would not be that helpful if only some thistle species were controlled and the door was left open for others to simply take their place once competition for space or other resources was removed. So for

Hierachical system used to classify plants

Kingdom
Phylum
Class
Order
Family
Tribe
Genus
Species
Variety
Form

Thistles in New Zealand

Number of species	115
Number currently considered economic weeds	9
Species known to be weedy elsewhere	38
Potential number of 'sleeper thistle weeds'	23–25

a successful multi-targeting strategy to be devised it would be necessary to understand how the various targets interact in an ecological sense, as well as their individual phenologies and population dynamics.

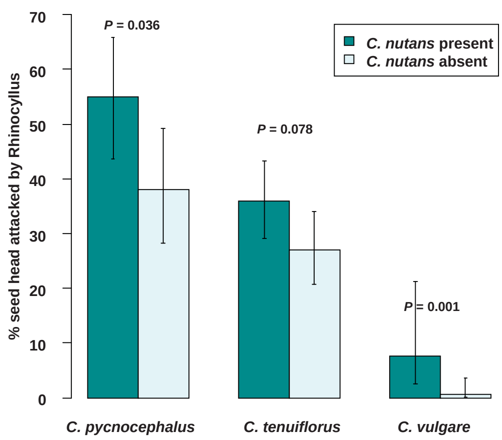
It has been suggested that multi-targeting is likely to work best when there is some overlap in the distribution of the primary target and secondary targets that allows spillover attack to occur, and is known as 'associational susceptibility'. Ronny undertook a study to check this out. By setting up trial plots and visiting field sites where various thistles co-occur Ronny was able to determine how the presence or absence of nodding thistle (*Carduus nutans*), the preferred host of the nodding thistle receptacle weevil (*Rhinocyllus conicus*), affected weevil attack of three less preferred hosts: Scotch thistle (*Cirsium arvense*), slender-winged (*Carduus pycnocephalus*), and winged thistle (*Carduus tenuiflorus*). "I found that the less preferred hosts were indeed attacked more heavily in the presence of nodding thistle," confirmed Ronny (see graphs). None of the less preferred hosts were attacked to a degree that would lead to population decline. Population decline is more difficult to achieve than slowing down or preventing spread of a weed, so multi-targeting is likely to be most effective when the secondary targets are sleeper weeds rather than well-established weeds, like the thistles mentioned above, but this will depend somewhat on the agents used.

Ronny examining one of her trial plots.

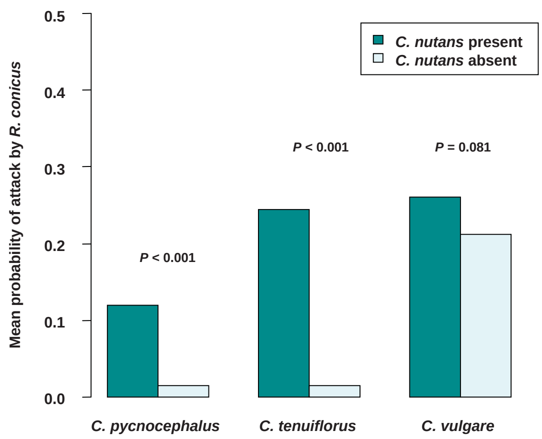
So multi-targeting might not be just a pipe dream but something that we could exploit in the future. Further analysis is needed to identify groups of plants in New Zealand that might be potential candidates for a multi-targeting approach, which will require detailed studies of their taxonomy and relationships with other undesirable and desirable species. Also, before leaping in, further studies need to be undertaken into the potential risks of releasing biocontrol agents with wider host ranges than have been the norm to date. Studies have shown that it is very difficult for insects with narrow host-ranges to be able to change and exploit new hosts, but generalist insects have much less difficulty, and the kinds of insects that might be used for multi-targeting are likely to lie somewhere in between. Because multi-targeting is likely to require fairly in-depth studies on the ecology and population dynamics of the target and potential weeds and possible agents, the extra effort might only be warranted where a number of sleeper weeds might be prevented from awakening.

This project was funded by the Foundation for Research, Science and Technology as part of the AgResearch-led Outsmarting Weeds programme, which concluded in October 2008.

Field experiment results



Field survey results



Things To Do This Autumn

Before winding down for winter there are a few things you might want to do:

Boneseed leafroller *(Tortrix s.l. sp. "chrysanthemoides")*
Check release sites. Look for the feeding shelters made by the caterpillars webbing together the tips of leaves. Small caterpillars are olive-green and become darker as they get older and develop rows of white spots along the length of their bodies. Hold off harvesting caterpillars until spring. We would be very interested to hear if you are able to find large numbers of caterpillars and/or damage.

Californian thistle gall fly *(Urophora cardui)*
Check release sites and surrounding areas for Californian thistles with swollen deformities on them. Galls that form in response to feeding by larvae of the Californian thistle gall fly may be as small as a pea or as large as a walnut and at low densities can be hard to spot. The galls are green but gradually turn brown as they mature during autumn. Mature galls can be harvested for release in other areas, but it would only be worth doing this in areas where there is little or no stock grazing.

Gorse pod moth *(Cydia succedana)*
Check pods for the gorse pod moth as the gorse seed weevil will not be around to confuse you. Look for the creamy-coloured caterpillars and/or their granular frass inside pods. You may also see small entry/exit holes in the pod wall. Although the moth is becoming widespread there are likely to be still some areas it has not reached. You can speed things up by taking branches with infested pods and wedging them into uninfested bushes this autumn.

Hieracium gall midge *(Macrolabis pilosellae)*
Check release sites for plants with swollen and deformed leaves caused by larval feeding. The only way to shift this agent around is by transplanting infected plants and it is best to wait until spring to do this.


Gall on Californian thistle.

Hieracium gall wasp *(Aulacidea subterminalis)*
Check release sites and surrounding areas for hieracium plants that have galls on the end of the stolons. In the autumn these galls can be harvested for release in new areas and it is best to leave them on the ground in a safe, sheltered spot.

Mist flower gall fly *(Procecidochares alani)*
Check release sites and surrounding areas for mist flower plants with swollen deformities on them. Galls that form in response to feeding by mist flower gall fly larvae reach up to 2 cm across once mature. If there are still areas where the fly is not present it may be worth harvesting mature galls and transferring them. Make sure only galls without windows are shifted otherwise the new adults will have already emerged.

Nodding thistle and Scotch thistle gall flies *(Urophora solstitialis and U. stylata)*
Check release sites and surrounding areas for fluffy-looking flowerheads that feel hard and lumpy when squeezed. If necessary collect infested flowerheads for release elsewhere. Hang them on a fence in an onion or wire mesh bag at the new release site. The galls will rot down over winter and the flies will emerge in the spring.

Website Update
We have made some substantial changes to the biocontrol of weeds section of our website, and hopefully it will now be much easier for all of you to find what you are looking for (see www.landcareresearch.co.nz/research/biocons/weeds/). If you have any further suggestions for improvements please feel free to contact Lynley Hayes (hayesl@landcareresearch.co.nz or Ph 03 321 9694).

Still Working after All These Years

November 2008 was the 10th anniversary of the release of the white smut fungus *(Entyloma ageratinae)* against mist flower *(Ageratina riparia)*. We decided to mark this milestone by returning to the field to reassess the impacts of both the fungus and the mist flower gall fly *(Procecidochares alani)*, which was released in 2001.

We always had high hopes for the success of this programme and put in place an ambitious monitoring programme in 1998 covering establishment, dispersal, and impacts of the two agents, and subsequent changes in vegetation. As we explained in *"Judgement Day"* in Issue 39 of this newsletter mist flower cover declined dramatically after 1998. The main beneficiaries of this decline, at least in the Waitakere Ranges, were native plants, but, to some extent also an up and coming weed, African club moss *(Selaginella kraussiana)*.

In November we were able to revisit 50 of the 110 plots in the Waitakere Ranges. Neither agent was released in these plots but quickly got there under their own steam. "Both agents are still abundant and mist flower remains under excellent control in the Waitakere Ranges," confirmed Jane Barton. The fungus was infecting, on average, 55.4% of living leaves (see graph). This is consistent with previous results, which showed that infection rates initially increased rapidly and levelled off after 4 years to around 58%. The fungus still appears to be having a dramatic impact on overall plant health and biomass.

The number of galls per stem showed a similarly impressive 100-fold increase from 0.007 in 2001 to 0.714 in 2003. "While less than 1 gall on average per stem may not seem a huge number, it is greater than the 0.46 galls/stem reported in a Hawaiian study, where the gall fly was considered to have contributed to the successful suppression of mist flower," explained Simon Fowler. It is therefore promising to see a similar level of galling maintained in 2008 (0.57 galls/stem), and concerns that parasites might quickly make inroads into gall flies remain unfounded.

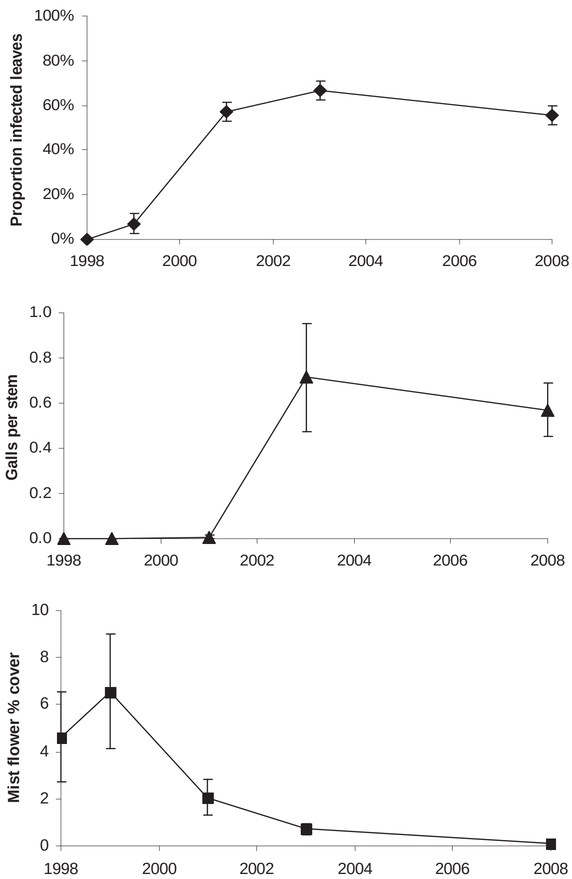
The height of mist flower plants has declined since 2001, when the fungus first reached most of our plots, but the most promising result as far as land managers are concerned is the continuing decline in the percentage cover of the weed. When the study was initiated mist flower was just beginning to invade the Waitakere Ranges and so it was not particularly dense in the study plots: in 1998 the average percentage cover was 5.45%, and the highest cover in any plot was 36%. Ten years later, average cover had been reduced by a factor of 34 to only 0.16%, and the highest cover in any plot was a paltry 0.46%.

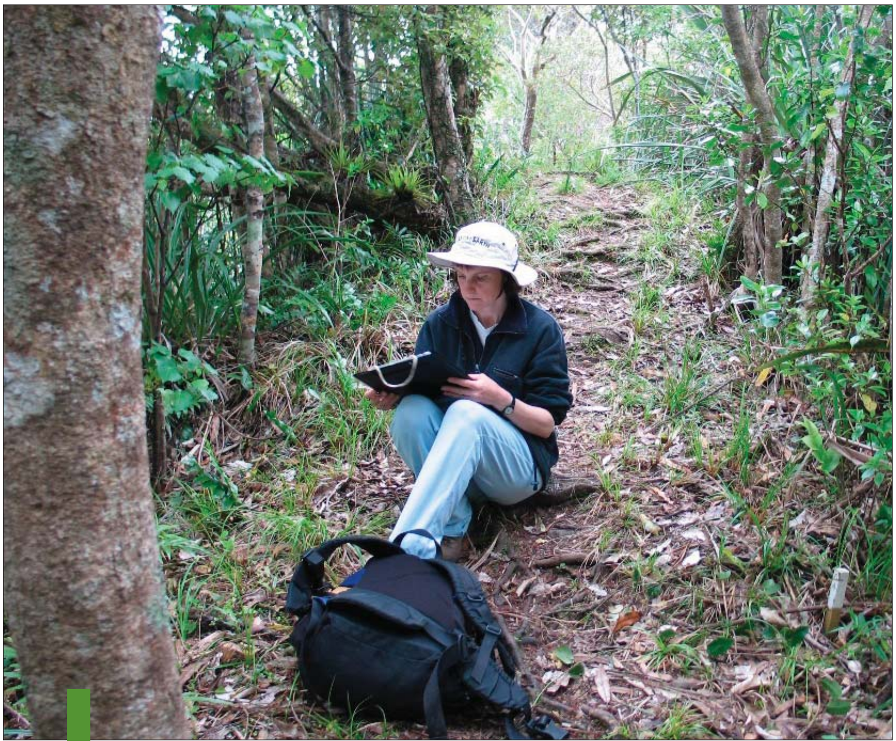
In June 2008 we also revisited gall fly release sites in the Karamatura Valley, where the white smut is also present. The number of galls per stem grew exponentially from 0.26 in 2001 to 1.96 in 2003, and then more slowly up to 2.29 in 2008. This high level of gall fly attack was sustained despite a dramatic decrease in the number of mist flower stems (four out of six quadrats sampled in 2008 had no mist flower), so clearly the gall fly is able to seek out and gall the plant, even when it is relatively rare.

Data from the Waitakere Ranges also tell us something about the impact of the biocontrol agents on the distribution and spread of mist flower. In the late 1990s mist flower was thought to be spreading rapidly into suitable habitats in northern areas of the North Island. Since our plots were chosen at random, mist flower was not present in every one in 1998 (20 of the 110 plots). In 2008 we deliberately chose to revisit areas where mist flower had been found in the past, but even so only 14 out of 50 plots had the weed. While mist flower has vanished from some plots it has also occasionally appeared in plots where it had not previously been recorded. It appears that biocontrol may cause local extinction of mist flower, but that some spread into optimal habitats is still occurring. The white smut and gall fly should quickly find any new infestations, and prevent them from becoming harmful.

Biocontrol is never likely to lead to the eradication of a target weed. The aim is to render the weed so non-competitive that while it may remain widespread, it is a minor and non-threatening component of the background flora. "This aim appears to have been well and truly achieved with respect to mist flower," concluded Jane.

Data from plots in the Waitakere Ranges





Jane hard at work assessing the plots.

Funding to do this follow-up on the mist flower project came from the Foundation for Research, Science and Technology's Beating Weeds programme. Jane Barton is a subcontractor to Landcare Research.

Name Changes

They have been up to it again unfortunately, doing detailed phylogenetics studies and changing the names of things. We are going to have to stop calling ragwort *Senecio jacobaea* in favour of *Jacobaea vulgaris*. Also mouse-ear hawkweed is no longer to be referred to as *Hieracium pilosella* but *Pilosella officinarum*. To ease the transition we intend to use both names for a while until people are more familiar with them.

Changes to Pages

If you are making an effort to keep your copy of *The Biological Control of Weeds Book – Te Whakapau Taru* up to date you need to go online and download some new and revised pages. Go to www.landcareresearch.co.nz/research/biocons/weeds/) and print out the following:

- Index
- How safe are biocontrol agents for weeds?
- Broom gall mite monitoring form
- Broom shoot moth monitoring form
- Green thistle beetle monitoring form
- Inundative control using mycoherbicides
- Californian thistle stem miner
- Pathogens on Californian thistle
- Tradescantia leaf beetle

Pathogen Queries

Sarah Dodd became a mother just before Christmas and will be on maternity leave until July when she will come back part-time. So if you have any pathogen-related queries, until advised otherwise please direct them to our other pathologist, Stan Bellgard (bellgards@landcareresearch.co.nz, Ph 09 574 4165).

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