What's New In Biological Control Of Weeds?

Annual Review

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What's Inside:

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Landcare Research

Introduction

Welcome to the first ever full-colour edition of *What's New in Biological Control of Weeds?,* which we have produced to help you keep your finger on the pulse of biological control of weeds projects in New Zealand. An important event during the past year was the 11th International Symposium on Biological Control of Weeds, which was held in Canberra, Australia, at the end of April. This symposium was attended by most of the main players involved in biocontrol of weeds worldwide. In this issue we feature some of the papers presented by the New Zealand contingent and others will be covered in future issues. We also report on other important happenings, both here and abroad, that have occurred over the past year.

Headlines

- Quite often biocontrol projects turn out to be harder than we expect. We relate some of the unexpected difficulties we have encountered in our relentless pursuit of agents for banana passionfruit.
- It's not enough to control a weed; in order to make a difference we need to replace it with more desirable species. Fortunately it looks like we have hit the jackpot with mist flower, at least in some situations. We reveal what's replacing mist flower as it beats a hasty retreat.
- Sometimes by the time we get called to help we know the situation is probably going to get worse before it gets better. We ponder the likely consequences if we are able to make inroads into mouse-ear hawkweed infestations in the high country.

- There were puzzled expressions when we discovered that one of our broom agents was unexpectedly attacking tree lucerne. At last we think we know why host testing failed to predict this result. We share the likely causes and possible implications for biocontrol worldwide. We also reflect on how well host-testing procedures have served us over the past 70 years.

- What goes up must come down? Hopefully not in the case of populations of biocontrol agents before they have had a chance to do their work! We say why we are convinced the weather was to blame for a recent poor showing by heather beetles.

- Although we have achieved control of alligator weed in some situations we would really like to shut it down completely. We provide a rundown on the newest potential biocontrol agents that could add a little more bite to the current line-up.

- It hopefully won't be long now till we get permission to release our first agent for boneseed. We take a look at the agents that have been released against this target in Australia and see how they are faring.

- Californian thistle is still proving to be an elusive target. We explain why our hopes may have been dashed yet again.

- In the past people thought that grasses were too difficult to target for biological control, but more recently people have begun to tackle them. We describe how people and systems have slowed down the *Nassella* project during the past year, not any inherent difficulties in working on grasses.

- Recently we have searched high and low for natural enemies of tradescantia in New Zealand. We shed light on why we think there is enormous scope for knocking this weed back with specialist agents from overseas.

- Woolly nightshade agents have proved a nightmare for our South African colleagues, as they have all demonstrated expanded host-ranges in the laboratory. We feature one small weevil that may make all the anguish worthwhile.

- Finally we provide a summary of who's who in biological control of weeds and the most important vital statistics you need to have at your fingertips, plus some tips for further reading.

Control Agents Released in 2002/03

Species	Releases made
Californian thistle gall fly (*Urophora cardui*)	1
Gorse colonial hard shoot moth (*Pempelia genistella*)	2
Gorse thrips (*Sericothrips staphylinus*), Portuguese strain	3
Hieracium gall wasp (*Aulacidea subterminalis*)	10
Hieracium gall midge (*Macrolabis pilosellae*)	12
Mist flower gall fly (*Procecidochares alani*)	1
Old man's beard sawfly (*Monophadnus spinolae*)	11
Scotch thistle gall fly (*Urophora stylata*)	2
Total	42

A Tribute

This newsletter is dedicated to the memory of my colleague Howard Bezar. Howard worked for Crop and Food Research here at Lincoln, where he was a fellow science communicator, until the tragic plane crash, which took his and seven other lives on the 6th of June 2003. Howard was responsible for informing New Zealanders about his organisation's research to develop better food and crops, and particularly in recent times about the pros and cons of genetic engineering. His wife, Christine, has made a great job of editing these newsletters for the past 5 years. I would like to acknowledge the contribution they have both made towards making science more accessible to all who benefit from it.

Lynley

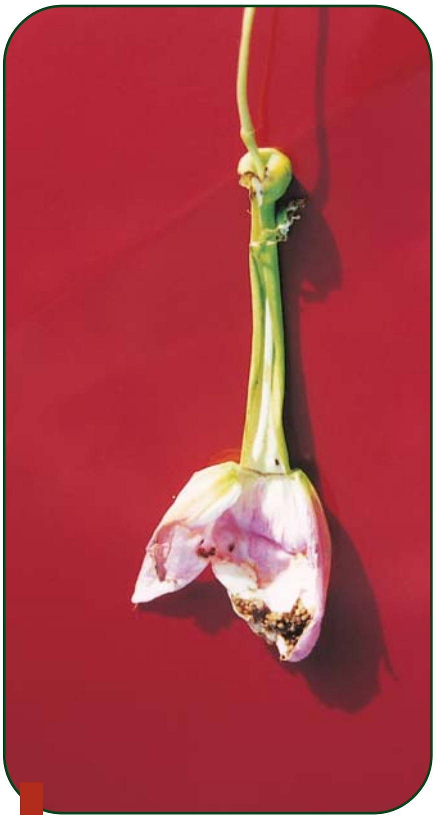
Lynley Hayes with her poster at the Canberra Symposium.

Passion Leads to Frustration

What's in a name?
Over the past year Murphy's Law ("anything that can go wrong will go wrong") has been an apt description of the banana passionfruit (*Passiflora* spp.) project. Any thoughts of a relatively easy ride, with us simply piggybacking on a parallel project in Hawai'i, have been dashed. Initially we thought we were dealing with only two targets (*Passiflora mollissima* and *P. mixta)*, but a recent taxonomic revision has turned them into four: *P. tripartita* var. *mollissima, P. tripartita* var. *azuayensis, P. tarminiana,* and *P. mixta*. Fortunately the taxonomists responsible for doubling our workload have also been able to help us tell them all apart.

This hasn't turned out to be our only taxonomic tribulation! Back in 1939 a taxonomist found a fungus on *P. mollissima* in Ecuador and called it *Septoria passiflorae*. Quite independently another taxonomist came across a fungus on several *Passiflora* species in South Africa 2 years later and by chance gave it exactly the same name. Forty years later a third taxonomist became suspicious about this and found them to be different species. The second fungus was given a new name and became *S. passifloricola*.

"*S. passifloricola* is recorded as a pest of commercially grown passionfruit (*P. edulis*) here and we have also found it once on one of the weedy banana passionfruit species, but it wasn't doing much damage," reports Jane Barton. Meanwhile the fungus said to be doing a great job in Hawai'i was supposedly *S. passiflorae*. However, our pathologists have examined several samples and think it's actually



Pyrausta perelegans caterpillars feed inside the flowers, preventing fruit and seed development.

S. passifloricola, raising doubts about whether *S. passiflorae* really exists. The original type specimen has gone missing so the only way we can lay the matter to rest is by attempting to collect *S. passiflorae* in Ecuador again. In the meantime we are still interested in the fungus being used in Hawai'i, whatever its identity turns out to be, because at the very least it appears to be a different strain with a different host range to what we have already got. Nick Waipara will be delving into this more deeply very shortly.

Jungle adventure
The road to finding suitable insect agents has also taken a number of twists and turns but fortunately the trail hasn't yet run cold. "Originally we thought that I would be able to work in Hawai'i on the three agents they had already imported," explained Hugh. But when it came time to begin, one of the agents, a foliage-feeding moth (*Cyanotricha necryia*), had failed to establish and another (*Pyrausta perelegans*) was rare and not collectable in sufficient numbers. The third, a bud-feeding fly (*Zapriothrica* nr. *nudiseta*), had not been released from captivity and had become inbred and died out soon after. This meant that an expedition was needed to the jungles of Ecuador to find ways of collecting

> " Hugh battled altitude sickness, bomb threats, and a petrol strike."

new populations of these insects and the mysterious *S. passiflorae*. Hugh immediately enrolled in Spanish lessons, and found himself a 'girl Friday' in the form of Charlotte Causton, who had done such things in Ecuador before and had even had a fly that feeds on banana passionfruit seeds named after her (*Dasiops caustonae*). Hugh battled altitude sickness, bomb threats, and a petrol strike in order to track down some people who can help us. It turns out that our best hope may be some researchers in Colombia. We hope that in due course our quarantine facility at Lincoln will be bulging with new inhabitants and are praying that this project has now used up its share of bad luck. After all doesn't perseverance in the face of adversity always pay dividends? Well they do say that Murphy was an optimist!

This project has been funded by a consortium of regional councils nationwide. Jane Barton works under subcontract to Landcare Research.

A Weed that Won't Be Missed

When the mist clears what will we see?

One of the perceived disadvantages of biological control is that, because we tend to use specialist agents with a narrow host range, there is a danger that if targets are successfully controlled then other weeds will simply replace them. Therefore it's not enough to show that biological control has cut a weed down to size; we also need to show that it has been replaced by something better. Jane Barton was able to deliver the good news at the Canberra Symposium that we have been able to show this for mist flower (*Ageratina riparia*).

During the summer of 1999/2000 we marked out more than 30 permanent plots in an area of native forest in the Waitakere Ranges, near Auckland, so we could document what happened when mist flower declined. Areas infested with the weed as well as areas still clear of it have since been the subject of close scrutiny. The white smut fungus (*Entyloma ageratinae*) got out of the starting blocks extremely quickly after its initial release in the summer of 1998/99 and began to affect the health of mist flower plants almost immediately. In fact researchers were not able to find any sites in the Auckland area that were free of the white smut that they could use as controls. Two years into the trial the average percentage cover of mist flower had decreased from 74% to 16%. "We are confident that this decline in cover was due to the severe defoliation caused by the fungus, as the mist flower gall fly (*Procecidochares alani*) had not yet reached the plots and there were no other environmental or management changes that could have caused such a dramatic loss of mist flower," explained Jane Barton.

Initially plots infested with mist flower had significantly fewer native plant species and more exotic plant species (over and above mist flower) than plots without the weed. This appeared to confirm the view of some land managers that mist flower was having a negative impact on the regeneration of native species and also facilitating the entry of (or at least, not inhibiting) other exotics. Encouragingly, exotic species have not seized the day as mist flower has begun to retreat and relinquish its territory. Even better, native species do appear to be taking advantage of the situation and are beginning to bounce back already. For example, along one walking track the average number of native species had jumped by 18% (from 9.1 species to 10.8 species per plot) only a little over a year after the white smut arrived in the area. While mist-flower-infested plots still have fewer native species, they are catching up fast. Of the plant categories examined, it is the woody dicotyledonous species that have benefited most from the biological control of mist flower so far, and almost all of these are native species.

Data based on species presence/absence suggest that biological control of mist flower is benefiting native species rather than other weedy exotics. Data on changes in percentage cover of each species are still to be analysed. We expect the gall fly to start to make its presence felt soon and will be eagerly following further changes in these plots for some years to come.

Galls continue to grow

All indications are that the mist flower gall fly is going from strength to strength with large populations building up extremely fast. For the past 3 years we have randomly sampled the number of

A plot in the Waitakere Ranges showing a large decline in mist flower cover and subsequent increase in native plants.

galls present at three sites in the Karamatura Valley, west of Auckland. We have found that the average number of galls per mist flower stem has increased exponentially at all three sites – more than doubling each year since measurements began (see table below).

Average mist flower gall fly infestation rates at three release sites at Karamatura

Date	Stems/ Quadrat	Galls/ Quadrat	Galls/ Stem
29 April 2001	37	6.5	0.2
9 May 2002	22.8	16.5	0.7
18 May 2003	25.2	44.7	1.8

Seona wearing her safety gear as she attends to her experimental plots at Whatipu.

A dynamic duo?

Conventional wisdom suggests the mist flower fungus and gall fly have worked well together in Hawai'i where the weed has been successfully controlled. Recently Seona Casonato has begun a postdoctoral study to check out whether 1+1 = 2 or whether the interaction between these two agents in New Zealand is instead synergistic, equivalent or inhibitory! She is conducting this study in a glasshouse setting as well as in the great outdoors.

Under glasshouse conditions Seona is subjecting mist flower plants to six different regimes: no control agents, both control agents at the same time, fungus only, gall fly only, gall fly released followed by the fungus 2 months later, and vice versa. All the test plants are covered in a fine mesh to confine the gall flies to the treatments where they are supposed to be. "Preliminary results so far suggest that plants subjected to the fungus-only treatment are not as tall as the others, but this may change over time," warns Seona.

Seona has set up field plots at Whatipu, west of Auckland, and is subjecting them to four treatments: no agents at all, gall fly only, fungus only, and both agents together. She has been applying fungicide and insecticide treatments regularly to maintain the first three treatments – both agents are extremely mobile and would otherwise quickly invade the trial plots where they are not wanted. She is currently analysing the preliminary data and initial results indicate there may be a difference in gall formation between the treatments. Galls have not developed on the "no agents" and "fungus only" plots (so the protection is working, which is a relief) and fewer galls have developed on plots with both biocontrol agents compared to the gall-fly-only plots. "We expect there will be some seasonal changes and that the interactions may change over time," predicts Seona. "These initial findings could still change substantially." The glasshouse trial will continue until flowering begins in the spring, and the field trial should be all wrapped up by the New Year. We will keep you posted on the final results of this project.

Seona's postdoctoral study is being funded by Landcare Research as part of its reinvestment scheme. The assessment trials have been funded by the Auckland Regional Council, with contributions also from Northland Regional Council, the Department of Conservation, Environment Waikato and the Foundation for Science, Research and Technology. Auckland University students carried out most of the fieldwork. Jane Barton works under subcontract to Landcare Research. A full report on the mist flower project from 2000–2003 is available from Lynley Hayes (hayesl@landcareresearch.co.nz).

Out of the Frying Pan into the Fire?

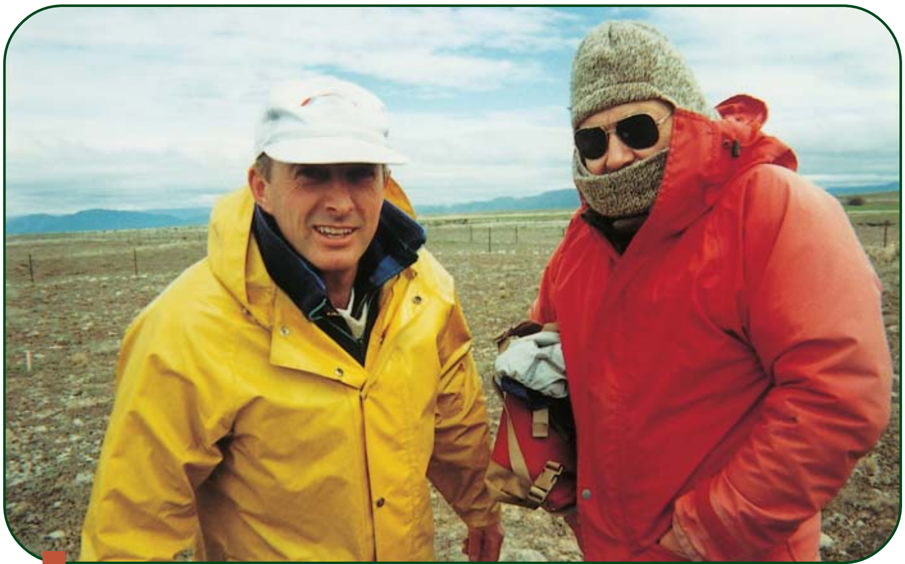
You might think that everyone would be highly in favour of biological control for such an insidious weed as mouse-ear hawkweed (*Hieracium pilosella),* but it has actually been quite a controversial project. In this case concerns about the potential for increased soil erosion were raised. Mouse-ear hawkweed tends to go hand in hand with overgrazed, degraded sites, and in some cases it's the only plant managing to hang on there and stabilise soil. We have responded by running a simulation experiment for a decade to explore what the outcomes of successful biocontrol might be and Pauline Syrett told the Canberra Symposium what it has revealed.

This experiment was conducted at two sites in the South Island's Mackenzie Basin: a fairly typical site (Maryburn Station) and a severely degraded one (Sawdon Station). Some plots were fenced to exclude grazing while others were left exposed. Small patches of mouse-ear hawkweed were repeatedly dosed with glyphosate herbicide to simulate attack by biocontrol agents. Species of plants present and their percentage cover, the amount of bare ground and litter were recorded at the beginning of the experiment and again annually.

"Vegetation responses varied between sites, and according to the grazing regime," revealed Pauline. At the degraded site, without grazing, mouse-ear hawkweed declined in control plots and this appears to have been due to periods of extreme drought. The amount of litter and bare ground increased initially in treated plots, but bare ground was quickly colonised by early successional species (lichens and mosses). Recovery was slower in the presence of grazing. "At the less degraded site, without grazing, mouse-ear hawkweed increased significantly in control plots at the expense of more desirable species," explained Pauline. In treated plots there was initially an increase in litter and bare ground but they were again soon colonised by mosses and lichens, and in this case by higher plants too. The effect was similar under grazing except that colonisation was slower. It was extremely positive to see that mouse-ear hawkweed could in fact be replaced by more desirable species even in the presence of grazing.

"Biological control outcomes are likely to vary according to the site," predicts Pauline. The degree of soil degradation, environmental conditions, and land management will all affect the outcome. At less degraded sites competing vegetation is likely to replace mouse-ear hawkweed as it comes under biological control. However, at severely degraded sites where conditions are extremely harsh, it is possible that removing mouse-ear hawkweed could result in a temporary increase in bare ground, until primary successional processes kick in. This trial has given us a glimpse of a worst-case scenario, as it is unlikely that biocontrol agents will be as effective as our herbicide treatments (where entire patches of mouse-ear hawkeed were removed annually), especially in situations where their host plants are stressed. If the threat of increased soil erosion at degraded sites is realised in future, then major intervention and restoration (e.g. direct drilling or oversowing of seeds of desirable plant species) may be necessary. However, the potential benefits of controlling mouse-ear hawkweed for either production or biodiversity purposes should still vastly outweigh the risks, and it is hoped that biological control will yet be the saviour of many farmers and indigenous species.

This project has been funded by the Foundation for Research, Science and Technology. Pauline Syrett is a research associate with Landcare Research.

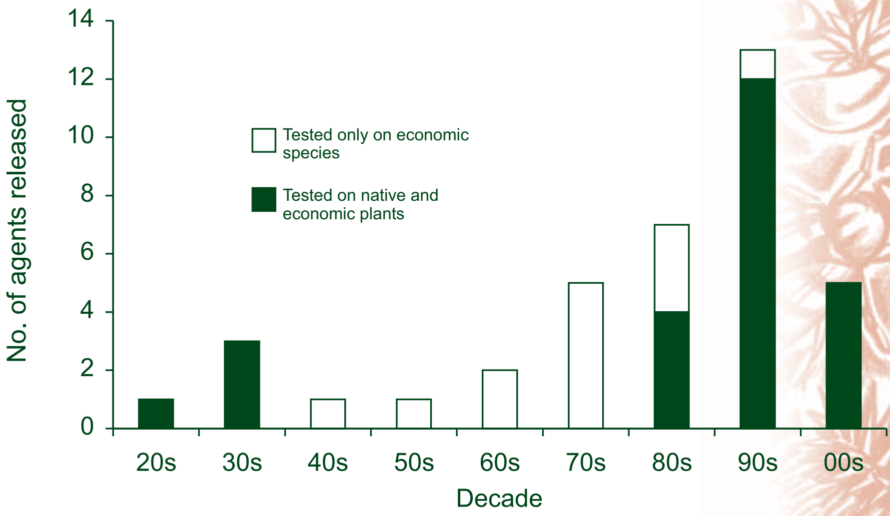


Lindsay Smith and Colin Meurk in danger of getting blown away during sampling at Sawdon Station.

In Retrospect

Looking for skeletons in the closet

In recent times some people have questioned the safety record of weed biocontrol. The two best-known examples of non-target attack being bandied around (the nodding thistle receptacle weevil, *Rhinocyllus conicus*, damaging native thistles and the famous prickly pear agent, *Cactoblastis cactorum,* damaging native cacti in the USA) were predictable from host-range testing. There are some examples of weed biocontrol agents damaging non-target plants that were not predicted from safety testing, but most of these appear to be transitory, "spill-over" effects when insect populations achieve extremely high densities before restraining forces kick in and reduce numbers. Encouragingly, there is no evidence of any evolutionary changes in the feeding preferences of weed biocontrol agents after release.



Number of biocontrol agents released against weeds in New Zealand per decade that were tested against native and economically important plant species prior to their release.

The lack of searching for non-target impacts in most weed biocontrol programmes has led to the suggestion that the few examples reported might only be the tip of the iceberg. Investigations to see whether any weed biocontrol agents have been misbehaving in New Zealand have in the past tended to been sporadic, and intensive localised surveys were carried out only if anything suspicious was reported – the outcome of these almost always being a case of mistaken identity. However, Simon Fowler told the Canberra Symposium that we have begun a comprehensive investigation into the safety record of weed biocontrol in New Zealand, and that proper searches for non-target impacts have become an integral part of biological control practice here.

Cinnabar caterpillars occasionally attack other Senecio *species, such as* S. biserratus.

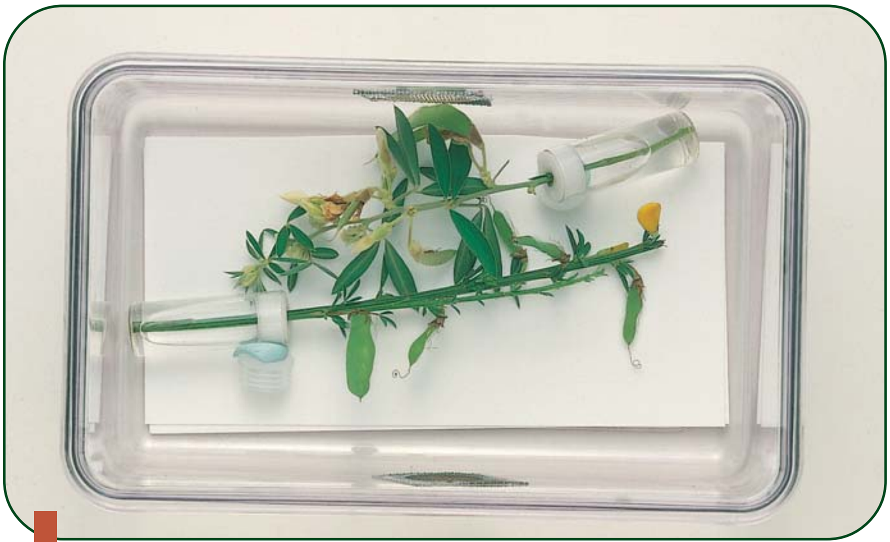
We have been checking back through old files to see if the testing methods used for all the agents that are now well established and common here were acceptable by modern standards. Biological control introductions began in New Zealand in 1929 and all agents have been subjected to some safety testing prior to release. "By and large, we consider that the testing methods used in the past were acceptable by modern standards, which is comforting," reported Simon. However, some inadequacies were identified in the testing of nine species.

It was a pleasant surprise to find that native plants were tested right back in the earliest days of biocontrol in New Zealand (see graph). Cinnabar moth (*Tyria jacobaeae*) was tested against eight native *Senecio* species, and the gorse seed weevil (*Exapion ulicis*) against three native members of the Fabaceae family. "However, from 1943 to 1982, there were 13 introductions that relied on testing carried out by programmes for other countries, where none of our native plants were tested," cautioned Simon. Since 1990, native plant species have always been included in any testing.

Our investigation has shown that where testing was adequate or good any possible worst-case scenarios of non-target effects that might be expected have not actually come to fruition. "This supports the widely held belief that host specificity testing usually overestimates the range of an agent, " explained Simon.

So what about the cases where the testing was considered inadequate in some way? Cinnabar moth (*Tyria jacobaeae*) larvae fed on other *Senecio* species in host-range tests, so occasional field attack on our native fireweeds might be expected. In fact the larvae do sporadically attack *Senecio minimus* and *S. biserratus* when they have completely defoliated ragwort (*Senecio jacobaea*) and are desperate for food. By modern standards the lack of inclusion of these native species in safety tests was an omission, but they were at the time classified in a different genus! To date this is the only weed biocontrol agent in New Zealand (of the 38 released so far) that has been found attacking a native non-target plant.

Another instance where plant species were omitted from testing involves agents brought in for alligator weed (*Alternanthera philoxeroides*). There are no native plant species in the same family as this weed, but in recent years a close relative, *A. sessilis,* has started to be used as a vegetable by Asian immigrants. "This creates a possible conflict of interest that did not exist when the agents were released in the 1980s," observed Simon. Overseas information suggests that the alligator



Broom seed beetle choice testing set-up.

weed moth (*Arcola malloi*) will attack other *Alternanthera* species, but that the alligator weed beetle (*Agasicles hygrophila*) is more specific. Because *A. sessilis* is not a common plant, manipulation experiments will be needed to test whether it is in any danger.

The only potentially serious impact on non-target native plant species in New Zealand could be from agents released against St John's wort (*Hypericum perforatum*). Again there was a reliance on overseas testing to assess the safety of two beetles (*Chrysolina* spp.) and a gall-forming fly (*Zeuxidiplosis giardi*). Although it was clear that other *Hypericum* species could be at risk, our native *H. japonicum* and *H. gramineum* were not tested. These two species are not common in New Zealand, and since the agents and the target weed also now occur sporadically, we will need to carry out some manipulation experiments to get to the bottom of this one too.

There are only two examples where test results did not predict non-target impacts, and with hindsight there were some flaws in the testing. The broom seed beetle (*Bruchidius villosus*) and gorse pod moth (*Cydia succedana*) have unexpectedly both been found attacking seed of other exotic members of the Fabaceae family – see *Learning from the past* below to find out what went wrong with the broom seed beetle. Research to uncover why we failed to accurately predict the gorse pod moth's host range is ongoing. Some of the avenues being explored include whether no-choice tests were carried out for long enough, whether there are any issues of seasonal timing of the moth and its host plants in New Zealand, and whether populations of the moths in Europe have slightly different host ranges. Observations of non-target attack by the moths so far seem to be highly variable both temporally and spatially, and may still prove to be just another "spill-over" effect. Interestingly both the broom seed beetle and gorse pod moth use

"The reliability of host-range-testing methods used in past weed biocontrol programmes for New Zealand has been high."

seasonally ephemeral resources, whose phenology differs somewhat between Europe and New Zealand, potentially offering novel no-choice situations to the agents once released here. "It may be that agents using discrete, seasonal resources need to be assessed even more carefully, " warned Simon.

Overall the reliability of host-range-testing methods used in past weed biocontrol programmes for New Zealand has been high. Biocontrol scientists worldwide are highly aware that they need to continually improve safety-testing methods and develop even more-robust procedures for assessing risk. The team here is no exception.

Learning from the past

We were a bit dismayed when we discovered in 1999 that one of our broom (*Cytisus scoparius*) agents was getting stuck into tree lucerne seeds (*Chamaecytisus palmensis*). Host specificity testing carried out before the broom seed beetle (*Bruchidius villosus*) was released into New Zealand and Australia had not tipped us off that this might be possible. Melanie Haines has been carrying out a PhD study, based at Lincoln University, to try to get to the bottom of this mystery and she presented her findings at the Symposium in Canberra.

The testing procedures used were scrutinised in fine detail to see if they yielded any possible clues. Much of the testing was carried out in the early 1980s and was therefore not quite as rigorous as would be demanded today. No-choice tests to see if the adults would lay eggs on other closely related pod-forming plants were carried out in the UK, as were a number of choice tests where the beetles were offered broom plus an alternative host at the same time. Later some choice testing of the beetles was carried out inside quarantine in New Zealand (and also in Australia during the 1990s) on additional plants not available in the UK, including tree lucerne. Tree lucerne originates in the Canary Islands so broom seed beetles would never have encountered it before.

There was some concern that a host-range expansion might have occurred since the beetles have been in the Southern Hemisphere. "I imported fresh beetles from the original population in the UK and retested them following previous protocols as closely as I could but with increased replication, " explained Melanie. "Despite showing a strong preference for broom, this time the beetles did go for tree lucerne, so we can be confident that a host range expansion has not occurred."

So why did we get different results second time round? We concluded that had no-choice tests or a higher degree of replication in the choice tests been used here in 1985 it is likely that damage to tree lucerne seeds would have been predicted. "However, at the time this testing was done, choice tests were in favour as they were considered to simulate more natural conditions than no-choice tests, and were often the only type of test used," confirmed Melanie. "We are confident this is not a host range expansion – it's another excellent example of how choice tests can fail to predict the acceptability of less preferred hosts." It is fortunate in this case that the non-target plant attacked is another exotic with weedy tendencies, and we do not think any other plants are likely to be at risk.

Melanie Haines getting up close and personal with broom.

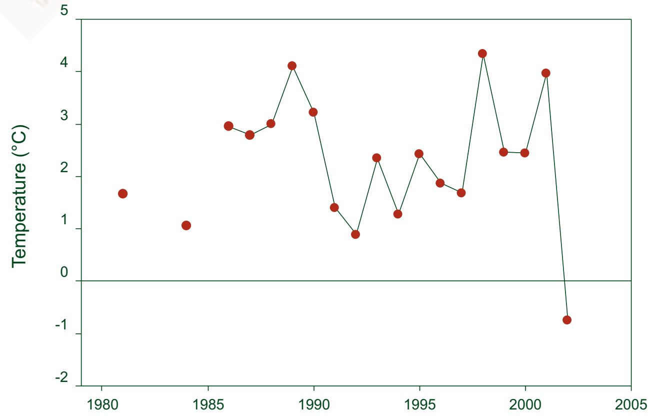
As the saying goes, we can only learn from past deficiencies. This study will help to shape future biocontrol best practice worldwide. The reality is that, in future, host-testing is likely to be more costly and time-consuming as we must, from necessity, increase the degree of replication and get even better at interpreting the results.

Both studies reported above have been supported by the Foundation for Research, Science and Technology. Melanie Haines' PhD study has received additional support from Lincoln University, the Miss E. L. Hellaby Indigenous Grasslands Research Trust, and a Claude McCarthy Fellowship.

Where Have All the Beetles Gone?

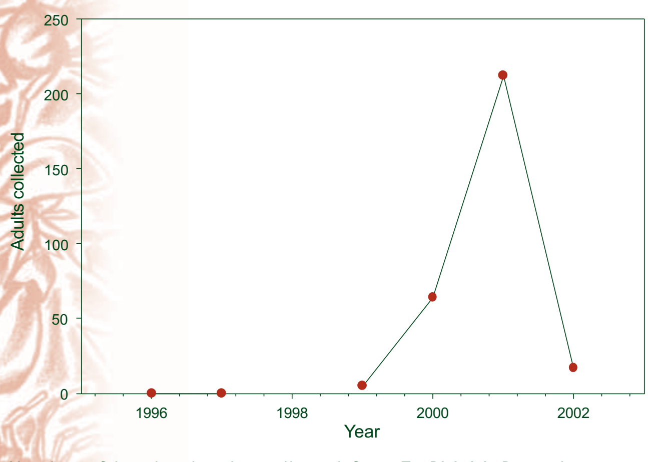
For the first year since establishment was confirmed in 1999, the heather beetle (*Lochmaea suturalis*) colony at Te Piripiri in Tongariro National Park appears to have gone backwards. "Initially it looked as though the population was doing well but by mid-December it became obvious that something was amiss," revealed Paul Peterson. Sampling during this period suggested that numbers had dropped back below December 2000 levels (see first graph). In Europe heather beetle populations are notorious for outbreaking sporadically and then collapsing again fairly quickly – a combination of parasitism and disease are thought to be responsible for this phenomenon. Obviously, if heather beetles could be freed from these limiting factors here in New Zealand, then outbreaks could be larger, more prolonged and even more devastating than they are in Europe. Consequently we have been keeping a careful eye out for anything that might interfere with our master plan. So what then appears to have gone wrong?

To date we have found some evidence of generalist predation. "Pitfall trap sampling in the area suggests that carabid beetles have been increasing in number, but we can't be sure that this is linked in any way to the heather beetles and we are pretty certain they haven't caused the crash," explained Paul. Other potentially important predatory species, e.g. bugs and spiders, do not appear to have increased in abundance. Small numbers of a native bug (*Cermatulus nasalis)* appear to be feeding on the larvae but this is also unlikely to be significant. Fortunately no evidence of the most dastardly demons, parasitism and disease, has been found.



Mean minimum temperature at Whakapapa for October 1981–2002.

Once we were able to discard predation, parasitism and disease as the likely causes of the crash we checked meteorological records to see if there was anything unusual about the weather during spring and early summer. Data from NIWA's meteorological station at Whakapapa (17 km NW of Te Piripiri and at a similar altitude) revealed that 2002 had in fact been an exceptionally cold year. Both October and November had the dubious honour of providing the coldest mean minimum temperature on record. In fact 2002 was the only year during the past two decades when the mean minimum temperature for October has dived below zero (see second graph). "However, keeping in mind that the crash did not become obvious until mid-December, late snowfalls in November are likely to have been important too," concluded Paul. Snow this late in the beetle's native range is virtually unheard of and may be something they are simply not adapted to cope with. Eggs and especially larvae would be vulnerable to freezing. Heather beetles collected towards the end of October had already begun to lay eggs, so the most fragile life stages would have been exposed to the unseasonably cold conditions. We now believe that the unusual weather last spring was to blame for the beetles' setback, and we will all be hoping for a much milder spring this year.



Number of heather beetles collected from Te Piripiri, December 1996–2002.

Fortunately we no longer have all our eggs in one basket at Te Piripiri, with the recent news that the beetles have established at a site in the Bay of Plenty, and possibly at two more sites in Tongariro National Park.

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

A–Z of New Developments Here and Overseas

Alligator weed

Our Australian colleagues have been making good progress in looking for additional agents in South America to increase pressure on alligator weed (*Alternanthera philoxeroides*), particularly terrestrial infestations. New insect agents that have recently been found include two chrysomelid foliage-feeding beetles (*Systena* spp.), a tiny fly that causes tip galls (*Clinodiplosis* nr. *alternantherae*), another fly that galls the nodes (*Ophiomyia marellii)*, a third fly that mines the leaves (*Ophiomyia alternantherae*), and two unidentified leaf-tying moths. Pathogens found include one known to have a wide host range (*Nymbia alternantherae)*, and another that causes a corky deformation of the stem and leaf surfaces and may be a new species (*Sphaceloma* sp.?). We hope to be able to find funding to ensure that plants of relevance to New Zealand are included in any host specificity tests carried out by our friends across the ditch. We still also have up our sleeve a couple of well-known insect agents, a species of thrips (*Amynothrips andersoni*) and a foliage-feeding beetle (*Disonycha argentinensis*), so the prospects for knocking alligator weed back further look promising. Our Australian colleagues are developing a model that will assist in figuring out the best way of shutting down this weed. We are hoping to organise a joint PhD student with the Co-operative Research Centre for Weeds in Australia, to study the ecology of alligator weed in New Zealand and Australia.


Mic Julien, CSIRO

Damage caused by thrips, a potential new agent for alligator weed in New Zealand and Australia.

Boneseed

An application to release the first agent for boneseed (*Chrysanthemoides monilifera* ssp. *monilifera*) in New Zealand has been lodged with the Environmental Risk Management Authority by Environment Canterbury. We hope this will prove to be a fairly straightforward application and that we will soon be up to our elbows rearing the boneseed leaf roller (*Tortrix s.l. sp.* "chrysanthemoides"). This damaging South African insect was released in Australia in 2000, and although establishment has been confirmed, populations are generally still low. Poor survival appears to be caused by strong competition between the caterpillars for feeding sites and the impacts of generalist predators such as ants and spiders. Where large numbers of ants occur, there has been no success in establishing this agent at all. Our Australian colleagues are looking into some alternative release techniques to try to overcome these problems.

Another moth *(Comostolopsis germana*) that feeds on the tips of boneseed plants is now established in Australia but it also suffers from ant predation. Luckily the ant fauna of New Zealand is more benign than that of Australia and we don't expect them to be such a hindrance here. A seed-feeding fly (*Mesoclanis magnipalpis*) has been released in Australia but its status is not yet known. A similar fly for bitou bush (*Chrysanthemoides monilifera* ssp. *rotundata*) has established there readily. Safety testing of a leaf buckle mite (*Aceria neseri*) has been completed in Australia and an application to release will be made soon. The Australians have also made considerable progress on the host-range testing of the rust fungus (*Endophyllum osteospermi*). Further testing of this pathogen will be required but is on hold at present.

The boneseed project in New Zealand is being funded by regional councils.

Californian thistle

In May we received a shipment of a root-feeding weevil (*Apion onopordi*) so we could safety-test it in containment at Lincoln. This agent is of special interest to us because of its ability to vector the rust fungus *Puccinia punctiformis*. The rust is common here and can be quite damaging, but it is limited in its ability to infect plants – we hoped that the weevil might be able to create widespread rust epidemics. "Unfortunately we have had some attack on globe artichoke (*Cynara scolymus*) and safflower (*Carthamus tinctorius*) so we will need to do more sophisticated tests and check if these plants are actually attacked in their native range," reports Hugh Gourlay. In an interesting aside, researchers in the United States have recently found the rust attacking variegated thistle (*Silybum marianum*) in a glasshouse situation. We would be interested to hear from anyone who has observed variegated thistle plants here that appear to be attacked by a rust (brightly coloured spores should be visible).

This project is being funded by the Californian Thistle Action Group through an AGMARDT grant.

The latest agent being considered for Californian thistle.

Nassella tussock and Chilean needle grass

Over the past few years we have been supporting the Australian project aimed at finding biocontrol agents for nassella tussock (*Nassella trichotoma*) and Chilean needle grass (*Nassella neesiana*) in Argentina. "Over the past year the project has run up against some unexpected difficulties, which have slowed progress temporarily," reports Jane Barton. The serious economic crisis in Argentina meant that a decision was made to pull out of there and continue the work in containment in Australia. Pathologist Freda Anderson gathered more than 20 strains of the rust (*Puccinia nassellae*) from all over Argentina and sent them to Australia. Unfortunately they have remained on ice ever since (in a freezer at –80°C) because the quarantine facility at the Keith Turnbull Research Institute had its clearance for such work revoked at the eleventh hour, and no other facility in Australia currently meets the new revised standards. Realising that it was going to take some time to satisfy the authorities, a decision was made to shift the work back to Argentina in the interim.

Strains of the rust occur on both grasses, sometimes killing plants in Argentina. The strain of the rust found on nassella tussock attacks both targets, whereas the strain on Chilean needle grass does not. The Chilean needle grass strain is, however, a lot easier to work with. Freda will work with the easier organism first and gain experience with it, before tacking the harder one. "We have sent over seed from New Zealand populations of Chilean needle grass to make sure they are susceptible to the rust," explained Alison Gianotti.

Another rust (probably *Uromyces pencanus*) that has more recently been found on Chilean needle grass in Argentina has now been added to the shortlist of pathogens worthy of further investigation. Further work on the smut (*Ustilago* sp.), which attacks the inflorescences of both *Nassella* species, and the Corticiaceous species, which can cause severe dieback of nassella tussock, will be tackled later. Neither pathogen is easy to work with and resources do not permit research into all potential agents to be carried out concurrently at present.

Grasses seem to be becoming increasingly popular biocontrol targets. Projects are now under way against *Sporobolus* spp. in Australia and *Spartina alternifolia* on the west coast of the United States.

New Zealand's contribution to the Nassella *project is being funded by regional councils.*

Tradescantia

This year we have carried out a survey to find out what invertebrates and fungi are associated with tradescantia (*Tradescantia fluminensis*) in New Zealand, which is an important first step towards developing a biological control programme for this weed. We found that this ground dweller is attacked by a wide range of native and exotic invertebrates and several species of fungi, but none of its specialised natural enemies. "Overall the amount of damage seen was minimal and it generally looked disgustingly healthy," reports Chris Winks. It appears that none of the niches available on tradescantia are well utilised in New Zealand, so there is considerable scope for introducing specialists that could markedly reduce the vigour of the plant. The next step is to begin surveys for potential agents in the plant's native range. Simon Fowler and Nick Waipara have been charged with this task and they have been setting up links with suitable collaborators in South America.

This survey has been funded by the Department of Conservation.

Woolly nightshade

Our South African colleagues have decided to pull out of research into woolly nightshade (*Solanum mauritianum*), at least for the time being. The project has been dogged by a succession of agents that have shown a liking during host-range testing for plant species that they have never been seen to attack in the field. Sorting through the minefield of ambiguous results has been really challenging. A sap-sucking lace bug (*Gargaphia decoris*) was approved for release in South Africa in 1999. Unfortunately it has not lived up to expectations, proving difficult to establish and not yet managing to build up to damaging numbers. It is thought that the reasons for its disappointing performance include poor climatic adaptation and interference from generalist predators such as ants, mirid bugs and ladybirds. New stocks of lacebugs imported from colder high-altitude areas in Brazil have now been released and it is hoped that they will do better.

A flowerbud-feeding weevil (*Anthonomus santacruzi*) is looking more promising. One of the main problems with woolly nightshade is its ability to produce vast numbers of bird-dispersed fruits, leading to constant reinfestation of cleared sites and invasion of new areas. If is thought that these weevils could severely hamper fruit formation, and an application to release them has been lodged in South Africa. Another similar weevil (*Anthonomus morticinus*) is also available and may be called up for action if *A. santacruzi* is approved for release. We hope to import *A. santacruzi* into quarantine in New Zealand during the coming year to assess its suitability for release here.

Meanwhile we have been following up on the mysterious fungus that we encountered at Wanganui during our survey 2 years ago. We found an *Alternaria* species on woolly nightshade that looks similar to the fungus that causes tomato blight (*Alternaria tomatophila*), and were unsure if it was a new, previously undescribed species for New Zealand. As the taxonomy of this genus is problematic we decided to send a live specimen to an overseas expert to have its identity confirmed. Despite returning to the exact site at the same time of year, and using a number of isolation methods, we were unable to recover the fungus again. Meanwhile a re-examination of our dried specimen and a study of the relevant literature has revealed that it is probably also a pathogen of tomato and/or potato, and therefore unlikely to be useful as a biological control agent.

The follow-up search for the mysterious pathogen has been funded by regional councils.

Terry Olckers, PPRI

A flower-feeding weevil that attacks woolly nightshade.

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, not yet released, application for permission to release currently with ERMA.
Broom psyllid (*Arytainilla spartiophila*)	Sap sucker, becoming more common, slow to disperse, one damaging outbreak 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 in spring, reducing flowering or even killing some bushes.
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, can cause severe damage to plants but overall impact unknown.
Gorse colonial hard shoot moth (*Pempelia genistella*)	Foliage feeder, limited releases to date, established at two sites, 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, 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, permission to release recently granted, rearing underway to enable releases to begin.
Hieracium gall midge (*Macrolabis pilosellae*)	Gall former, widespread releases have begun, establishment looks promising at oldest release site, impact unknown but very damaging under laboratory conditions.

Hieracium gall wasp (*Aulacidea subterminalis*)	Gall former, recently released widely, established but not yet common in the South Island, establishment in North Island not confirmed yet, 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, only one release made so far and success unknown, rearing underway to enable 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 at least one site there and at Rotorua, severe localised damage seen already.
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, only recently released but establishing readily, already common at some sites, impact not yet known.
Nodding thistle crown weevil (*Trichosirocalus horridus*)	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, often causes obvious damage.
Old man's beard leaf miner (*Phytomyza vitalbae*)	Leaf miner, common, laboratory studies suggest it is capable of stunting small plants at least, one severely damaging outbreak seen so far.
Old man's beard sawfly (*Monophadnus spinolae*)	Foliage feeder, widespread releases have now begun, 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 occuring pathogens under development as mycoherbicides, e.g. fusarium blight (*Fusarium tumidum*), silver leaf fungus (*Chondrostereum purpureum*) and white soft rot (*Sclerotinia sclerotiorum*), are not included in this table.

Further Reading

Barton, J. (née Fröhlich); Webster, R. A.; Boow, J.; Ragiel, H.; Edenborough, K.; Whaley, K. (in press): **Evaluating the flow-on effects of the biological control agents for mist flower (*Ageratina riparia*) on plant succession.** Proceedings of the 11th International Symposium on Biological Control of Weeds, Australian National University, Canberra, Australia, 28 April – 2 May 2003.

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Fowler, S. V.; Gourlay, A. H.; Hill, R. L.; Withers, T. M. (in press): **Safety in New Zealand weed biocontrol: a retrospective analysis of host specificity testing and the predictability of impacts on non-target plants.** Proceedings of the 11th International Symposium on Biological Control of Weeds, Australian National University, Canberra, Australia, 28 April – 2 May 2003.

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Gourlay, A. H. 2002: **Host specificity of *Agonopterix ulicetella* (Stainton) (Lepidoptera: Oecophoridae), a potential gorse control agent in Tasmania.** Landcare Research Contract Report LC0102/090.

Haines, M. L.; Syrett, P.; Emberson, R. M; Withers, T. M.; Fowler, S. V.; Worner, S. P. (in press): **Ruling out a host range expansion as the cause of the unpredicted non-target attack of tagasaste (*Chamaecytisus palmensis*) by *Bruchidius villosus*.** Proceedings of the 11th International Symposium on Biological Control of Weeds, Australian National University, Canberra, Australia, 28 April – 2 May 2003.

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Stanley, M. C.; Fowler, S. V. (in press): **Conflicts of interest associated with the biological control of weeds.** Proceedings of the 11th International Symposium on Biological Control of Weeds, Australian National University, Canberra, Australia, 28 April – 2 May 2003.

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Waipara, N. W. 2003: **Evaluation of *Phoma exigua* var. *exigua* as a biocontrol agent against Californian thistle (*Cirsium arvense*).** Proceedings of Biocontrol of Weeds with Pathogens, a workshop held in association with the 8th International Congress of Plant Pathology, Canterbury Agriculture and Science Centre, Lincoln, Christchurch, New Zealand, 1 February 2003. Pp. 31–32.

What's New in Biological Control of Weeds? issues 1–24 are available from Lynley Hayes and issues 11–24 are available from our website (details below). If you need assistance in locating any of the above references please contact Lynley Hayes.

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