What's New In Biological Control Of Weeds?

What's Inside:

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Wedding Present for Bridal Creeper

New Zealand recently received an unexpected but welcome present. Chris Winks noticed a rust on bridal creeper (*Asparagus asparagoides*) growing in a barberry hedge near Auckland Airport in November. It turned out to be the bridal creeper rust (*Puccinia myrsiphylli*). The rust was discovered right at the outset of a survey to find out what invertebrates and pathogens are present on bridal creeper in New Zealand. "With any biocontrol project it is important to check what's already here at an early stage and this is a great example of why we need to do these underpinning surveys," explained Chris. "We could have wasted a lot of time and money on testing and seeking permission to import this rust when it was already here." It seems most likely that this South African fungus has come via Australia, where it has recently been released as a biocontrol agent.

Bridal creeper, also commonly known as smilax, is a scrambling or twining perennial vine that can grow up to 3 m tall when supported by other vegetation. This garden escapee invades forest margins, open woodlands, waste places, hedges, coastal slopes, and roadside banks. It is very competitive, preventing other plants from getting both sunlight, via its dense canopy, and access to the soil, via its thick mat of rhizomes and tubers. In New Zealand bridal creeper is common in the northern half of the North Island, but becomes less common the further south you go. It is also ranked amongst Australia's worst environmental weeds. In southern Australia it has shown an alarming ability to spread (mostly through its bird-dispersed berries) and outcompete more desirable vegetation. Bridal creeper has an even

Chris Winks at the scene of his special discovery.

more sinister attribute in that it can invade relatively undisturbed habitats.
Bridal creeper is closely related to another unwelcome invader, climbing asparagus (*Asparagus scandens*), but unfortunately the rust is too host specific to attack this weed as well. Safety-testing has also shown that the rust released in Australia is unlikely to damage cultivated asparagus (*Asparagus officinalis*) or any other plants, although a number of New Zealand species should be tested to confirm this. The rust causes the weed to divert nutrients away from healthy plant tissues, resulting in defoliation, and reduced growth, fruit and tuber production.

A biocontrol project targeting bridal creeper got underway in Australia in 1990. Three biocontrol agents have been released: a leafhopper (*Zygina* sp.) in 1999, the rust fungus in 2000, and a leaf beetle (*Crioceris* sp.) in 2002. So far, the rust fungus appears to be the most effective of these agents, and it is reducing the aggressiveness of the weed in many areas.

Both the rust and the leafhopper were found to be slow to disperse (moving only metres in the first months after release). Therefore community groups, land managers and schools were encouraged to become involved in the release, redistribution and monitoring of these agents. This strategy has proven very effective as more than 1500 releases were made across the country by December 2003. The widespread nature of the rust in Australia may also help to explain how it reached us relatively quickly. Six years may not seem that fast, but it took about the same length of time for someone to notice blackberry rust (*Phragmidium violaceum*) in New Zealand after it was released in Australia, and blackberry rust disperses quite readily.

Since the discovery of the bridal creeper rust in New Zealand our staff have been working to determine its current distribution. We are gathering this information in two ways. Firstly, our staff are looking for the rust as they undertake the original survey, and secondly, a call has gone out for biosecurity officers, Department of Conservation staff and other interested people to keep an eye out and send in material from any sick-looking bridal creeper plants.

"There has been a great response to our request for material, with samples and observations coming in from all over the country. So thanks very much to everyone who has helped out," said Helen Harman. For those who haven't managed to check their bridal creeper infestations yet, it's not too late! Rust symptoms should be obvious again when the plant begins to regrow in the autumn. Normally healthy shiny green leaves become yellow, tan and brown (similar to plants that have been sprayed with herbicide). The rust appears as yellow and black spots (pustules) on the underside of the leaves, and on berries and stems. "Because the plants die back naturally at the end of summer, it is important to check for the distinctive pustules," confirmed Nick Waipara. If you see any plants that look infected, please note their location and collect a sample (green leaves with pustules are best), put them in a paper bag and send them to the address below. Digital photos of damage would also be useful. Please note, records of places the fungus hasn't reached yet are also important, so if you can't find the rust, please tell us that too. We are also interested in gaining a better picture of the distribution of bridal creeper, so records of where plants do and don't occur would also be useful.

So far the rust has been found at: Whatitiri (Northland), Waiheke Island, several sites around Auckland City, Mangere (Auckland), Papakura and Drury (south of Auckland), Waihi Beach and Pahoia Rd (Western Bay of Plenty), and Akitio (Wairarapa). So it would seem quite likely that the rust has either made landfall in several parts of the country or has been here unnoticed for a couple of years. We are hoping to find additional funding to enable us to study the rust more fully and make recommendations about how best to use it against bridal creeper. Hopefully the honeymoon phase for bridal creeper is over!

- Send diseased material and photos to Paula Wilkie, Landcare Research Private Bag 92170 or, for courier delivery, 231 Morrin Road, Tamaki, Auckland.
- Send information about the distribution of bridal creeper and any other observations to Helen Harman (harmanh@landcareresearch.

This survey is being funded by a national collective of regional councils and the Department of Conservation.

Diseased bridal creeper leaves.

Hot Gossip

In a flurry of activity before Christmas the **Environmental Risk Management Authority** (ERMA) made a number of decisions that put smiles on the dials of biocontrol researchers. They approved the release of the **buddleia weevil** (*Cleopus japonicus*) and researchers at Ensis (formerly Forest Research) hope to begin making releases in February. Approval was also given for us to release the **two new ragwort moths** (*Platyptilia isodactyla* and *Cochylis atricapitana*), and mass-rearing is already underway. Initially releases will be made on the West Coast but should be available for other areas in 2006/07. ERMA also gave us permission to import into containment **two new broom agents**, a foliage-feeding moth (*Agonopterix assimilella*) and a gall-forming mite (*Aceria genistae*). A triple-banger application to release these agents plus the broom leaf beetle (*Gonioctena olivacea*) will be lodged with ERMA shortly.

Unfortunately there have been delays in getting a shipment of **boneseed leafroller** (Tortrix s.l. sp. "chrsanthemoides") from South Africa and we are now expecting one to arrive in March. The moth is often heavily parasitised in its homeland, so there has been some effort required to produce a clean population for us. All going well it may still be possible to make a small number of releases this autumn, but the majority will need to be deferred until next spring.

Together with the Marlborough District Council we held a field day in Blenheim in December to enable people to learn about and collect the **gorse soft shoot moth** (*Agonopterix umbellana*). The moths were discovered to be doing well at this site last year. Although the site was not as spectacular this year there were still ample caterpillars, and as a bonus **gorse thrips** (*Sericothrips staphylinus*) were found to be well established there too. Regional council staff from as far afield as Auckland and Southland attended in the hopes of establishing the moths more widely. A good contingent from Horizons Regional Council and Tasman District Council joined in too. The moth is now widespread in Marlborough with some people discovering the moths were already present when they went to release them. The moth is also continuing to do well in Canterbury, but continues to be elusive in the North Island.

Gorse soft shoot moth field day at Blenheim.

Why Flea Beetles Fail

We now have a better idea of why the ragwort flea beetle (*Longitarsus jacobaeae*) has not been able to successfully control ragwort (*Senecio jacobaea*) on the West Coast, thanks to an intensive study. Ragwort grows very well on the Coast. Overseas studies have shown that ragwort populations do best when there is high rainfall and ground disturbance, and both these events are common on the West Coast. At the same time high rainfall probably has a negative effect on flea beetle populations as beetle density appears to be lower at higher-rainfall sites. The level of beetles per plant was lower at West Coast sites than at some East Coast sites where control has been achieved. Previous work has suggested that you need at least four beetles per rosette in order to get control. On average in our Coast study we never counted more than three. The highest number of beetles recorded on a single rosette was only 10 whereas as many as 50 have been recorded from a single rosette in Auckland. Unlike other parts of New Zealand the beetle is only able to complete one life cycle a year on the Coast. So it seems that West Coast conditions conspire to let ragwort do very well but not the beetles.

Brazilian Excursion Bears Fruit

Last November Nick Waipara and Simon Fowler returned to Brazil to continue work on the tradescantia (*Tradescantia fluminensis*) project. First up they went to the laboratory of Professor Pedrosa (University of Parana) in Curitiba, where an as yet unidentified species of thrips is heavily damaging tradescantia and looking quite promising. Tradescantia-infested sites near Curitiba were also revisited, and the damage caused by a promising yellow leaf spot, (*Kordyana* sp.), quantified. An unidentified leaf-curling gall midge was also collected. A fancy light-meter, borrowed from our botanists at Lincoln, was used to measure light levels reaching the plant through tree canopies. "The plant is noticeably less vigorous in Brazil, which appears to be due to the combined impacts of its natural enemies and not because of light limitation," confirmed Simon. The light meter, which resembles a Star Wars light sabre and comes in a 1.3-m-long carrying case, raised a few eyebrows at airports en route … "it that a weapon, Sir?" To which it was tempting to reply "you'd better ask my colleague Obe Waipara Kenobi…!," confessed Simon.

However, the main purpose of the trip was to look for potential biocontrol agents in areas not previously surveyed. Nick and Simon headed south, driven and guided by Dr Robert Bareto (University of Vicosa) and two PhD students. They made collections from near sea level to up around 1000 m, repeatedly driving up the impressive escarpments of the southern plateaus. "The trip saw us on the road early most days and we sampled until it got too dark," confided Simon. By all accounts it was a spectacular success.

"We discovered a new rust fungus," explained Nick. "We also found lots of the yellow leaf spot, which should increase our chance of getting isolates that attack New Zealand tradescantia – this has been a barrier to progress so far as the one isolate collected to date was too host specific!" revealed Nick. Three promising new insects were collected: a sawfly, a microlepidopteran (very small moth), and a leaf-mining beetle. Typically, insects in these taxa, or with these feeding strategies, are host specific, so they have been placed high up an ever-increasing list of promising agents to study.

Many tradescantia samples for DNA analysis were also collected, for two reasons: firstly, to check that the plant being surveyed is actually *T. fluminensis* and not another closely related species – they can be quite tricky to tell apart; and secondly, to identify *T. fluminensis* populations that are most similar to ours, which is important to know when selecting isolates of highly host specific pathogens such as the yellow leaf spot.

Progress has also been made with some of the potential insect agents identified previously. "The foliage-feeding beetle (*Buckibrotica cinctipennis*) that caught our eye early on has been demoted down the priority list because of rearing difficulties and the suggestion from experts that a beetle from this group is unlikely to be sufficiently host specific," confessed Simon. The top contender currently is another promising beetle (tentatively identified as *Lema cornuta*) whose adults and larvae cause high levels of damage to tradescantia. The translucent, pear-shaped, slimy larvae (complete with frass that they eject onto their backs as extra protection from predators) were instantly dubbed 'Jabba the Hutt' larvae by Nick. Their star-shaped pupal cases are by contrast quite a work of art. However, looks aside the main consideration remains their culinary preferences, which will be explored in the near future.

This project is funded by a national collective of regional councils and the Department of Conservation.

The yellow leaf spot on tradecantia.

May the Force be with you Simon!

Things To Do This Autumn

Autumn often involves a final burst of activity on the biocontrol front before the cold weather sets in. Some of the things you might need to do include:

- Checking if bridal creeper rust (*Puccinia myrsiphylli*) has found its way to your area (see page 1). Please let Helen Harman know about any confirmed sightings or places where the rust does not appear to be present yet (harmanh@landcareresearch.co.nz).
- Checking gorse thrips (*Sericothrips staphylinus*) release sites. Yes we know they are small and hard to see but we suspect they are actually becoming a lot more common and widespread than we previously thought! We recommend you check all gorse and not just release sites. It is best to check when bushes are not flowering so you don't confuse gorse thrips with flower thrips (*Thrips obscuratus*). If you have good eyesight you may be able to see the tiny black adults or paler juveniles sitting on the foliage, especially in the growing tips. If your eyes aren't too sharp then beat branches over a piece of white card or material and with the help of a magnifying glass check out the smallest creatures you can see. Gorse thrips tend to jump rather than fly, as they don't usually have wings. We would be very interested to know of your findings.
- Checking gorse for the gorse pod moth (*Cydia ulicetana*). Autumn is the best time of year to check pods for the creamy-coloured caterpillars, when there is no chance of confusing them with gorse seed weevil (*Exapion ulicis*) larvae. You can tell when a caterpillar has eaten all the seeds and moved on because they leave behind some frass and an exit hole. Again you might be surprised where you find them once you start looking. Also keep a look out for the small brown adult moths fluttering around gorse bushes, especially on sunny, calm days. If you need to introdtuce the moth to new areas simply cut off branches with infested pods and wedge this material into gorse bushes at new sites.
- Checking sites where any of the gall-forming agents have been released. The mist flower gall fly (*Procecidochares alani*), hieracium gall midge (*Macrolabis pilosellae*), hieracium gall wasp (*Aulacidea subterminalis*), and Californian thistle gall fly (*Urophora cardui*) all cause swellings that develop through summer and become most obvious in early autumn. If present in good numbers you could harvest mature galls and release them at new sites. With the hieracium gall midge however, you will need to wait till next spring and transplant whole infected plants.
- Harvesting Scotch and nodding thistle gall flies (*Urophora stylata* and *U. solstitialis*). Keep an eye out for mature flowerheads that look fluffier than usual. Give them a careful squeeze and if they feel hard and lumpy they are infested. Put infested flowerheads in an onion or wire mesh bag, or similar, and hang it on a fence at the new release site. The galls will slowly rot down over winter and the flies will emerge in the spring and attack the thistles.
- Harvesting and redistributing nodding thistle crown weevil (*Trichosirocalus horridus*) and ragwort flea beetle (*Longitarsus jacobaeae*). Take time to check through the material you collect to ensure you are not spreading pests, such as the clover root weevil (*Sitona lepidus*), as well as the biocontrol agents.

Don't forget to take your field guide along with you, and let us know how you get on!

What gorse thrips look like under high magnification (top) and about double the size that they are in real life (below).

How Successful Will They Be?

One of the commonest things we get asked (after what will they eat next?) is how successful biocontrol agents are or are likely to be. In this article we explore why follow-up is important, how we go about it, and why it is difficult to answer these questions!

Picking winners

Since we aim to introduce the least number of exotic organisms as possible that can do the job, a lot of thought goes into selecting the ones that might be most effective. Agents that have multiple generations a year will often have an edge on those that only breed once a year. We also know that some kinds of damage, such as to the roots, are more devastating to plants than others, and what kinds of agents have been most successful in the past. We can also get some idea of the impact various agents have on target weeds in their homeland, but this may not translate very well to what might happen here where they will be faced with different predators, parasites, and land management and climatic regimes.

We can make some predictions by simulating biological control. For example, biocontrol of hawkweeds (*Hieracium* spp.) was simulated by applying herbicide to targeted areas for over a decade before control agents were released en masse. The results suggested that on the whole the weed should be replaced by more desirable plants, but at highly degraded sites there could be a temporary increase in bare ground that may need to be managed.

Computer models are powerful tools we can use to make all kinds of predictions, but they are not yet available for many weeds. Landcare Research and AgResearch are jointly developing models that will hopefully help us to pinpoint the most vulnerable stage in the life cycles of both environmental and pastoral weeds, and how to best target these. The Foundation for Research, Science and Technology is funding this work as part of the "Beating Weeds" and "Outsmarting Weeds" programmes.

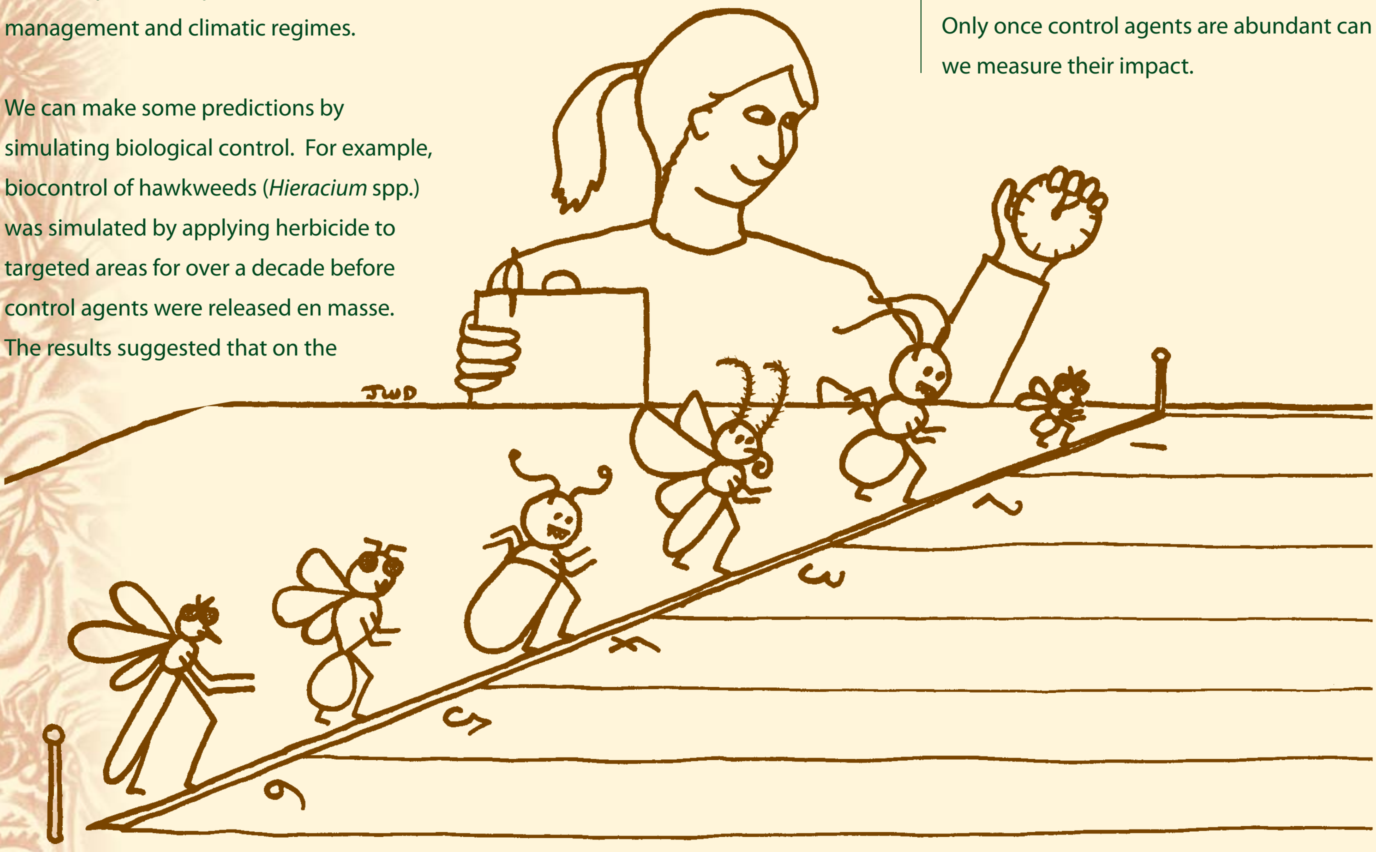
Following up

Undertaking meaningful follow-up on released agents is not usually a quick, simple or cheap exercise. However, we need to bite the bullet and do it anyway.

If we know that biocontrol isn't likely to be able to deliver adequate results, we may need to seek additional agents or develop other control methods. On the other hand if we can provide concrete evidence that biocontrol is a success, it is a huge boost to the morale of all those involved, and helps to secure funding to enable biocontrol to be developed for other targets.

Getting started

The first thing to do is check that biocontrol agents have established (which given that you are introducing tiny fragile organisms into a big wide world is no mean feat) and how quickly they might be spreading. We call this monitoring. With the help of regional council staff and others we undertake where possible to check all release sites at least once. If an agent is deemed to have failed to establish (which we may not know for many years) then obviously no other follow-up is required. If an agent has established but is still rare, then we keep a watching brief until it hopefully becomes more common. Only once control agents are abundant can we measure their impact.



Measuring up

There are a number of ways of measuring the impact of biocontrol agents, each of which has its pros and cons. One of the simplest approaches if to see if an agent is capable of damaging individual plants. We do this by comparing the growth of plants under attack with plants free from attack, while keeping all other variables the same. In this way we were able to show, for example, that gorse spider mites (*Tetranychus lintearius*) stunt the growth of gorse bushes (*Ulex europaeus*). While studies of individual plants are useful (if you can't demonstrate impact at this level there is no point in doing anything more sophisticated) it doesn't tell you the consequences of this damage for weed populations, which is usually of more interest.

Why photos can lie

One of the simplest assessment methods for assessing changes to weed populations is a series of "before" and "after" photos. To be convincing the photos need to be taken at exactly the same place, angle, and time of year, and preferably include permanent landmarks or other features. Given that changes to infestations (especially long-lived plants) may taken many years to show up, a set of photos taken over a long period is likely to be more convincing than a single "before" and "after" shot. Although the photos may look like compelling proof they at best only suggest a correlation (a relationship between two things). It is possible that something else (like a change in land management) is responsible for a weed declining. However, it is important that we all keep taking photos! If pictures showing the same trend are taken at many sites or over many years, then the probability of actual cause and effect may be greater, especially if the effect is only observed where the agents are established. We also tend to have short memories and it can be really useful to remind ourselves of how things used to look, and have visual representations to support hard data.

Cunning plots

So how do we get these hard data? Generally we set up some kind of plots that can be used to make comparative measurements. The simplest technique involves measuring the amount of weed and control agent present over a number of years. In this way we were able to show that mist flower (*Ageratina riparia*) steadily declined at all the release sites where we released the white smut (*Entyloma ageratinae*). Again this is not proof of cause and effect, but because the data were gathered at many sites in different regions over a number of years it strongly suggests that the biocontrol agent was responsible.

A more sophisticated assessment technique involves setting up replicated plots that are as identical as possible in every way except for the presence or absence of control agents. If a control agent is not yet widespread, we can collect baseline data about the weed infestation for a couple of years and then add the control agent to half the plots and measure subsequent changes for a couple of years. However, given that control agents are mobile it can be difficult to keep them out of the plots that are meant to be uninfested!

If the control agent is widespread, then we can remove them from half of the plots, using a suitable insecticide, and measure subsequent changes. The protocol used needs to be carefully thought out and tested so that the insecticide does what you want and doesn't have other confounding effects on your plots. We have used both these techniques for demonstrating the effectiveness of ragwort flea beetle (*Longitarsus jacobaeae*). These techniques are most suited to short-lived species like ragwort (*Senecio jacobaea*) and thistles (*Carduus* and *Cirsium* spp.). For long-lived plants like gorse and broom (*Cystisus scoparius*) it is more practical to use models to predict impact than to maintain plots and make measurements for decades.

Staying true

Biocontrol is a low-risk way of controlling weeds and everyone is keen to keep it that way. The art of designing, undertaking, and interpreting results of safety-tests is constantly being evaluated and fine-tuned. It is important then as part and parcel of any assessment programme to check predictions made about the likely host range of agents prior to release against actual behaviour in the field. Once agents are well established field surveys should be undertaken to check that plants most likely to be at risk are not being harmed. Comprehensive field surveys have now been undertaken for nearly all well-established control agents in New Zealand.

To conclude

Current techniques do not allow us to predict the impact of control agents with any degree of certainty because of the complexity of natural systems. At best we get a steer in the right direction. With the help of regional council staff, in particular, we are able to keep a reasonable handle on establishment success. However, not enough time has yet elapsed for us to go that step further and evaluate the impact of many of our agents, especially given that it is the combined impact of suites of agents that really counts and agents tend to be drip-fed into the system. Models are currently only available for a few weed species but more are currently being developed. The impact of biocontrol agents can be extremely variable in both time and space and we will often at best only have information relating to a few sites in one or two seasons. However, the major obstacle is funding. Many funders of biocontrol would prefer to support research to develop control agents for new targets than measure what may appear to be blindingly obvious. Assessment studies, if done properly, are not cheap. The challenge then is for scientists to persuade funders to support the assessment component of projects and find quicker and smarter ways to predict and assess success.

Upcoming workshops

We are intending to run an advanced Biocontrol of Weeds workshop at Lincoln on 28–29 March 2006. This course is best suited to people who have previously attended one of our basic courses or who have had lots of practical hands-on experience with biocontrol. We are also intending to run a one-day workshop at Tamaki, Auckland, in late May or early June. This will be an opportunity for anyone interested in biocontrol to come along and update themself about what is happening with all of our biocontrol projects. If you are interested in attending either event (which will be free of charge) please contact Lynley Hayes (hayesl@landcareresearch.co.nz, Ph 03 325 6701 ext 3808).

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