What's New In Biological Control Of Weeds?

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What's Inside:

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Introduction and Headlines

Welcome to the fifth 16-page edition of this newsletter which we produce annually to help you keep your finger on the pulse of biological control of weeds in New Zealand and overseas. We report on important happenings and progress over the past year.

- Two new agents to attack thistles have been approved by ERMA and one will be released soon.
- Lots of good potential agents for tradescantia (*Tradescantia flumensis*) have been found and an application to release the first one is being prepared.
- A survey of natural enemies of bridal creeper (*Asparagus asparagoides*) in New Zealand has revealed that the self-introduced bridal creeper rust (*Puccinia myrsiphylli*) is the only thing causing significant damage.
- Ecologists and mathematicians are getting together to identify ways of improving weed management.
- Surveys to look for potential control agents for Japanese honeysuckle (*Lonicera japonica*) are underway in Japan and have already uncovered some curious beasts.
- A good contingent of Kiwis headed over to France in April for the XIIth International Biocontrol of Weeds Symposium and some also attended the VIIIth International Bioherbicide Group Workshop. We report on what they had to share with the rest of the world as well as some of the most interesting things they heard.
- Spring can be the busiest time of the biocontrol of weeds year – we remind you about some activities you might need to be planning.
- We provide a summary of the current status of all our weed biocontrol agents, plus some tips for further reading.

New Thistle Agents Ready to Go

Good news! ERMA has given the Californian Thistle Action Group (CTAG) the all-clear to release the green thistle beetle (*Cassida rubiginosa*) and the Californian thistle stem-mining weevil (*Ceratapion onopordi*). We imported populations of both from Switzerland in the middle of the year and since then have been busy determining the best way to rear them. The beetle has been easy to rear and we have now been able to remove them from quarantine. We are hoping that releases will be able to begin later this year, with the first ones earmarked for the Otago and Southland regions where CTAG is based. CTAG has been patiently supporting us to find better ways to beat Californian thistle (*Cirsium arvense*) for nearly a decade, so it is great to finally have something to give them.

Green thistle beetle larva.

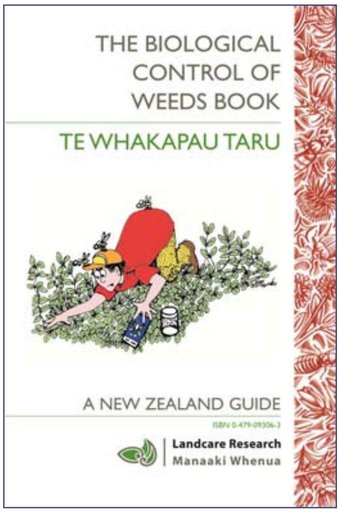
It is taking longer to figure out the weevil. "They have been laying lots of eggs, unfortunately too many per plant, so the plants were sickening before the larvae could move onto healthy ones," said Hugh Gourlay. The weevil adults need a winter conditioning period before we can take them out of quarantine. However we are unlikely to have enough to make any releases this year so they will have to wait until the following spring.

This project is funded by CTAG through a MAF Sustainable Farming Fund Grant.

Changes To Pages!

Just a reminder that *Te Whakapau Taru – The Biological Control of Weeds Book* is now online and you can download any pages you want. Since the book went online in June (see www.landcareresearch.co.nz/research/biocons/weeds/) the following pages have been further revised and new versions posted in early July:

- Boneseed leafroller
- Enhancing biocontrol of broom by using modelling predictions
- Gorse pod moth
- Gorse spider mite
- Index
- Old man's beard sawfly
- Pathogens on Californian thistle
- Ragwort flea beetle



Control Agents Released In 2006/07

Species	Releases made
Boneseed leaf roller (*Tortrix s.l.* sp. *"chrysanthemoides"*)	1
Gorse colonial hard shoot moth (*Pempelia genistella*)	5
Gorse soft shoot moth (*Agonopterix ulicetella*)	10
Broom leaf beetle (*Gonioctena olivacea*)	3
Hieracium gall midge (*Macrolabis pilosellae*)	1
Hieracium root hover fly (*Cheilosia urbana*)	3
Ragwort crown-boring moth (*Cochylis atricapitana*)	5
Ragwort plume moth (*Platyptilia isodactyla*)	18
Total	**46**

Tracking Tradescantia's Enemies

Preliminary results comparing the damage caused by insects and pathogens to tradescantia (*Tradescantia fluminensis*) in New Zealand with its home range in Brazil have reinforced the potential for biocontrol of the plant in New Zealand. As a result of extensive surveys a range of species have been found to be associated with tradescantia in Brazil and some appear to be quite damaging. The maximum area of tradescantia leaves damaged by natural enemies in Brazil was 90–100% whereas in New Zealand it was only 5–15%.

We have seen impressive damage caused by pathogens. "Some of the sampling sites we returned to at the end of the season were unuseable due to the weed having turned into diseased mush," said Nick Waipara. This result is likely to have been helped along by insect attack and secondary diseases, but there is evidence it was started by some primary pathogens, and five species are of interest. A rust fungus (*Uredo* sp.) and a yellow leaf spot (*Kordyana tradescantia*) are the most widespread and cause the most damage. Unfortunately none of the rust strains collected so far appears able to infect New Zealand material. We remain hopeful, though, and have put "trap" plants out around Brazil – this is often the best technique for finding a suitable strain when you are unsure of the provenance of your material. A strain of *Cercospora apii* that does infect New Zealand tradescantia is now being tested to check out its host range. The remaining two leaf diseases, *Ceratobasidium* sp. and *Mycosphaerella* sp., are being assessed for their ability to infect and cause disease.

Surveys have uncovered 42 insect species associated with tradescantia in Brazil. While many are yet to be properly identified, and some are likely to be new to science, we already have a shortlist of eight prospective agents. Four beetles head the list. *Lema* sp. nr *guerini* is a leaf-feeding beetle that has been found only on *T. fluminensis*. While we have seen moderate damage in the field, it caused major defoliation to potted plants in the laboratory. As a bonus it is fairly easy to collect in the field and to rear. Presently we are completing tests of the beetle's host specificity in quarantine at Lincoln, and are beginning to prepare an application for its release.

Two beetles, also tentatively identified as *Lema* species, have been found. The larvae of one can destroy growing tips and the other bores into the stems. "Common sense suggests that damage from the three beetles could be complementary," said Simon Fowler. A PhD student, Sue Molloy, will be addressing this issue as part of a study of the population dynamics and management of the weed. Adults of the fourth beetle (*Buckibrotica cinctipennis*) appeared to be quite host-specific in preliminary testing and cause impressive damage to tradescantia both in the lab and the field. However, we have not yet worked out rearing methods for the root-feeding larvae and therefore cannot complete host-specificity testing at this time.

One of the *Lema* beetles and its feeding damage.

Other insects on the shortlist include a species of thrips, a sawfly, and a gall midge. During the field survey we found quite high levels of damage caused by the thrips and sawfly. These species have not yet been identified and we are still working out how to rear them. Consequently, none have been host tested yet. All three are types of insect that we know from experience are often very host-specific.

The final two species of interest are moths (*Idioglossa* sp. and *Mouralia tinctoides*). They are further down the list of priorities because they are not very common and therefore not easy to find and collect for further study. *Idioglossa* is likely to be quite host-specific and can be very damaging, but appears to be vulnerable to parasites. *M. tinctoides* is not specific to tradescantia and attacks other species in the family Commelinaceae. However, there are no native or economically important plants in Commelinaceae in New Zealand and no native plants even in the order Commelinales. This broadens the scope for potential biocontrol agents for New Zealand as they do not have to be specific to genus or subfamily.

This project is funded by the National Biocontrol Collective and the Foundation for Research, Science and Technology as part of the "Beating Weeds" programme.

Just Rust

All the excitement happened at the start of the survey of bridal creeper (*Asparagus asparagoides*) in New Zealand. At the very first site checked in 2005 we found the bridal creeper rust (*Puccinia myrsiphylli*) (see *Wedding Present for Bridal Creeper*, Issue 35). But that turned out to be the only cause for excitement, as the rust is the only species causing significant damage to the plant in New Zealand. The rust was released as a biocontrol agent for the weed in Australia and appears to have made its own way over the Tasman Sea. A molecular analysis of the rust has confirmed Australia as the likely source. Of the 37 field sites surveyed, ranging from Northland to Banks Peninsula, this fungus was found at over a third and it appears to be spreading quickly. The rust is now present in Northland, Auckland, Bay of Plenty and the Wairarapa. Bridal creeper stems, shoots, leaves and fruit are all vulnerable to attack and the damage caused is often severe – plants can lose all their leaves.

At least 25 different fungal diseases were isolated from infected bridal creeper leaves, stems and tubers. However, they cause minor damage. One species, *Colletotrichum gloeosporioides*, was found throughout bridal creeper's range. "While it caused only mild damage on its own this was increased, as was its infectiousness, when associated with bridal creeper rust infection," said Nick Waipara. It appears these two may form a mutually beneficial disease complex when they occur together.

The rust is the only species causing significant damage to the plant in New Zealand.

While a wide range of native and introduced invertebrates nibble on bridal creeper in New Zealand, again little damage is caused. Caterpillars, particularly leaf-rollers, and slugs and snails caused the most noticeable damage to bridal creeper leaves. At some sites thrips were present in large numbers, indicated by silvery-coloured patches on leaves. "Two sap feeders, the passionvine hopper (*Scolypopa australis*) and *Siphanta acuta*, were the only plant feeders that were abundant on the weed," said Chris Winks. These findings show that no herbivore niches are very well occupied on bridal creeper in New Zealand, which means there is space for specialists to move in. Neither of the insect biocontrol agents that have been released in Australia, the leaf hopper (*Zygina* sp.) and leaf-feeding beetle (*Crioceris* sp.), was found. Nor was anything found that might interfere with any insect biocontrol agents if they were needed in the future.

The report concludes that as bridal creeper rust is widespread and can cause severe damage to bridal creeper, our next priority should be to establish exactly how well it is doing in New Zealand. "Monitoring the rust's impact on the biomass and spread of the weed should take place before we start investigating any additional biocontrol agents," said Helen Harman. It may be that no additional agents are required.

One step that should be taken is to apply to ERMA to "de-new" the bridal creeper rust under the Hazardous Substances and New Organisms Act (1998). Because the rust was not present in New Zealand before the cut-off date of 29 July 1998 it is considered a new organism. The Act prevents new organisms from being reared or shifted around New Zealand. Because the rust has self-introduced and is well established, it is appropriate to apply for its status to be altered, which would allow land managers to actively propagate and disperse it to areas that have not yet been infected.

This survey was funded by the National Biocontrol Collective. The molecular study of the rust was funded by the Auckland Regional Council.

Rust-infected bridal creeper. Insert: Magnified rust spores.

Australian Bridal Creeper Biocontrol Update

Australian biocontrol scientists presented an update on their bridal creeper program at the recent Biocontrol of Weeds Symposium in France (see *The French Connection*, page 7). Bridal creeper rust was released in Australia 7 years ago and impressive damage has been documented. Recently studies have been conducted to quantify the rust's impact, using glasshouse and field experiments. Glasshouse experiments compared the impact of defoliating the plant by hand to that of the rust on the growth of bridal creeper tubers and shoots. "The results showed that spraying the weed with the highest density of rust spores (10^5 spores/ml) had a similar impact as removing between 50% to 75% of the plants leaves," said Louise Morin (CSIRO). When left for a further 5 months most of the plants sprayed with the highest spore density, and a few of the 100% defoliated plants, did not regrow at all. Researchers also conducted potted plant experiments to determine the impact of the rust in the field. After 6 months, the above and below ground biomass of the infected plants was significantly lower than that of the healthy control plants. Bridal creeper naturally dies back over summer and 4 months later the control plants had regrown extensively while the infected plants had produced few (if any) new shoots and tubers.

The bridal creeper leaf beetle (*Crioceris* sp.) was released in Australia in 2002. It attacks young bridal creeper shoots and is active earlier in the growing season than the other biocontrol agents. Unfortunately, it has not been establishing very well and research has recently been undertaken to work out why. Results from field experiments indicated that predation might be a factor limiting beetle establishment but more work is needed to confirm this. Releasing large numbers of beetles or using exclusion cages at the time of release may compensate for any predation that may occur.

Maths Joins Ecology to Take On Weeds

The benefits of mathematicians and ecologists working together were highlighted by a recent workshop in Hanmer Springs. Fifty participants from a wide range of organisations gathered together to exchange ideas and set up research projects, kicking off a 3-year programme Modelling Invasive Species and Weed Impacts (MISWI), funded by the New Zealand Institute of Mathematics and its Applications (NZIMA).

Staff from the Department of Conservation opened the workshop by outlining their weed problems and suggesting ideas for how mathematics, statistics, and modelling might help them with their day-to-day weed challenges. Similar talks described the challenges faced by regional councils and people in the agricultural sector.

Presentations from mathematicians and ecologists then described a gamut of approaches to weed ecology, from theoretical models to hands-on field techniques. Common themes were "How do you find them?", "How do you contain them?", and "How many do you need to kill?" Speakers from Canada, USA, UK and Australia detailed how maths has been used to help weed management overseas.

Discussion groups tackled weed risk assessment and control, long-range dispersal, heterogeneous landscapes, and surveillance and monitoring. These debates were often vigorous and occasionally uproarious, but gave the participants from different disciplines an understanding of other's expertise. The workshop generated the commitment to ongoing research collaboration between mathematicians and weed ecologists, which had been the main aim of the gathering.

The MISWI programme is based at the University of Canterbury, see http://www.math.canterbury.ac.nz/bio/NZIMA.

Jon Sullivan

Colin Meurk of Landcare Research talks to conference delegates about weeds.

Japanese Adventure

Recently Landcare Research signed a Memorandum of Understanding with the National Institute of Agro-Environmental Sciences (NIAES) in Japan, paving the way to begin our first biological control programme against a weed of Asian origin. In May Quentin Paynter and Sarah Dodd travelled to Japan for further discussions about possible collaborative projects and to begin a preliminary survey of the natural enemies of Japanese honeysuckle (*Lonicera japonica*). They uncovered a number of suspects that may be responsible for keeping the plant in check there. Japanese honeysuckle is locally common in its native range, particularly in disturbed areas such as on embankments in forest edges and agricultural areas. However, even in these areas it does not dominate to the extent that it can in New Zealand.

The survey for prospective biocontrol agents has brought several insects to our attention as worthy of further investigation. We collected a moth (*Apha aequalis*) and two butterflies (*Limenitis camilla*, the white admiral, and the closely related *L. glorifica*), the caterpillars of which feed on Japanese honeysuckle leaves. All are quite attractive species, the adult butterflies have black wings with striking white spots and the moth's caterpillars are large and fluffy. However, all are likely to attack other *Lonicera* species, and the moth also feeds on plants from other genera in the Caprifoliaceae. While there are no native plants in this family in New Zealand there are a few ornamental honeysuckle species grown here, and it is likely that we will need agents with a higher level of specificity.

The white admiral, while attractive, is unlikely to be sufficiently specific.

Other insects that have caught our attention include a stem-boring beetle (*Oberea mixta*), an aphid (*Trichosiphonaphis lonicerae*), and a leaf-feeding sawfly. "The sawflies were found at quite a few sites but we did not see any adults, just larvae, and so have been unable to identify them yet, but they are probably a species in the genus *Zaraea*," said Quentin Paynter. According to our Japanese colleagues, Japanese sawflies have not been studied much, so it may not be a formally described species. As well as the sawflies, quite a few insects found during the survey could not be identified, particularly caterpillars and pupae. Our Japanese colleagues are trying to rear these through to adults so we can find out what they are.

Akihiro Konuma and Quentin Paynter examine Japanese honeysuckle.

We did not pick up many pathogens during the survey and think that it may be due partly to the time of year (spring). "We did notice a downy mildew on several plants, a couple of leaf-spots, and symptoms of what are probably viral diseases and we are in the process of identifying them," said Sarah Dodd.

Our colleagues in Japan have been looking at the genetics of Japanese honeysuckle and comparing plants from Japan and New Zealand. They have found that the New Zealand material is unexpectedly diverse. Akihiro Konuma (NIAES) suspects that our plants originated from three introductions, two from Japan and another possibly from Korea. It is valuable to know the provenance of a weed because some potential agents might be specific to a particular biotype or race (see *Tricking Tradescantia's Enemies*, page 3). With many specimens still to be identified and more field surveys in Japan planned we are confident we will find some agents that are capable of containing this out of control climber.

This project is funded by the National Biocontrol Collective. Quentin and Sarah's trip to Japan was also supported by a grant from the Royal Society of New Zealand under their International Science and Technology Fund.

The French Connection

In April a good contingent from Landcare Research, as well as students and biocontrol of weeds scientists from AgResearch and Ensis, made the long journey over to France for the XIIth International Symposium on Biological Control of Weeds. This Symposium is held every four years and is the most important conference for us in terms of keeping up with the latest developments, thinking, and best practice in the field, as well as renewing old acquaintances and making new ones – given the international nature of our work it is critical that we remain well connected with other scientists throughout the world! Some of our staff also attended a meeting of the International Bioherbicide Group that was held immediately beforehand (see *Plant Pathologists Gang Up on Weeds*, page 12).

The Symposium was held at La Grande Motte, in the south of France, about 30 km from Montpellier, where French biocontrol of weeds scientists are based. La Grande Motte was built on the coast in the 1970s to develop tourism in the area, and it is now a popular destination during the high-summer season. La Grande Motte means "the big sand dune" and a number of the buildings, including apartment blocks, are built to mimic sand dunes and waves. New Zealand plants are all the rage, with cabbage trees and flax planted everywhere. Let's hope they don't go on to become invasive…

Lynley Hayes and Sarah Dodd amongst the baccharis at Sollac.

La Grande Motte is on the edge of the famous Carmague region renown for its pink flamingos, white horses and black bulls. A field trip to a typical coastal marsh, called Sollac, enabled us to learn about the weed challenges threatening this area. A 5-year project is being undertaken at Sollac to address biodiversity conservation in these wetland sites. The main weeds threatening the area are baccharis (*Baccharis halimifolia*), pampas (*Cortaderia selloana*), water primrose (also known as primrose willow) (*Ludwigia peloides*), and silk vine (*Periploca graeca*). In New Zealand baccharis is controlled by Environment Canterbury on the Port Hills and pampas is of concern to many, especially in the north. At Sollac it was interesting to see in their native environment some plants that are weeds here, especially yellow flag iris (*Iris pseudacorus*), whose flowers were crawling with a cute little weevil, and some incredibly puny little horsetails (*Equisetum* spp.).

Carmague horses with yellow flag iris in the foreground (the foals turn white as they age).

Landcare Research staff gave a number of oral presentations at the Symposium:

- Simon Fowler gave a keynote address on "Release strategies in weed biocontrol: how well are we doing and is there room for improvement?" See page 8 for more.
- Simon Fowler also presented a paper on "Benefits to New Zealand's native flora from the successful biological control of mist flower (*Ageratina riparia*)" on behalf of Jane Barton. The benefits of this highly successful project were reported previously (see *Judgement Day*, Issue 39).
- PhD student Ronnie Groenteman presented a talk titled "What species of the thistle biocontrol agent. *Trichosirocalus* are present in New Zealand?" Look out for a story about this in a future issue.
- Helen Harman spoke about "Morphological and genetic methods to differentiate and track strains of *Phoma clematidina* on *Clematis* in New Zealand". A report on this

project will also be included in a future issue.

- Quentin Paynter talked about "New biological control agents for Scotch broom in New Zealand: dealing with the birds and the bees and predicted non-target attack to a fodder crop". The main points from Quent's talk have been covered in a previous issue (see *Biological Control of Broom – Is It Worth It?* Issue 28; *Bees Busted* and *Broom Round Up*, Issue 38).
- Lynley Hayes' presentation, "Avoiding tears before bedtime: How biocontrol researchers could undertake better dialogue with their communities", covered communication challenges facing biocontrol of weeds practioners and the potential power of using an approach known as dialogue. This work has also previously been reported (see *What Do People Really Think about Biological Control of Weeds?* Issue 28).

Our staff also contributed to oral presentations made by key collaborators such as Richard Hill, who presented a review entitled "A global view of the future for biological control of gorse", and Robert Barreto, who spoke about "Pathogens from Brazil for classical biocontrol of *Tradescantia fluminensis*".

Malcolm (Nod) Kay from Ensis spoke about the Biological Control of Buddleia project in New Zealand (see *Buddleia Weevil Blooms*, page 11).

Below we feature some of the work presented at the Symposium that most grabbed our attention.

We also prepared and displayed the following posters:

- Ecology, impact and biological control of the weed *Tradescantia fluminensis* in New Zealand, and herbivorous insects from Brazil for classical biocontrol of *Tradescantia fluminensis*.
- Altered nutrient cycling as a novel non-target effect of weed biocontrol.
- Factors affecting oviposition preference in the weevil *Rhinocyllus conicus*.
- The degree of polymorphism in *Puccinia punctiformis* virulence and *Cirsium arvense* resistance: implications for biological control.
- Ragwort flea beetle (*Longitarsus jacobeae*) performance reduced by high rainfall on the West Coast, South Island, New Zealand.
- Prospects for biological control of banana passionfruit in New Zealand with a leaf pathogen *Septoria passiflorae*.
- Opening Pandora's Box? Surveys for attack on non-target plants in New Zealand.
- Midges and wasps gain tarsus hold – successful release strategies for two biocontrol agents for hawkweeds in New Zealand. .

Release Strategies – How Are we Doing and Is There Room for Improvement?

It is by no means a given that biocontrol agents will establish after release and it is very disappointing when they occasionally vanish without a trace. Sometimes a failure to establish may be due to factors outside of our control, such as extreme weather events. The key thing is to focus our efforts on where we can make a difference. Simon Fowler has recently reviewed what the biocontrol community has learnt about establishing biocontrol agents over the years.

A chap called Allee suggested in 1949 that some animals do better when they are in groups. The term "Allee effects" refers to factors that cause organisms to do more poorly when they are in low densities, such as difficulty finding mates. They are of interest not only in establishing biocontrol agents, but also in conservation of rare species, and even in pest management when there is a need to eradicate a low-level pest.

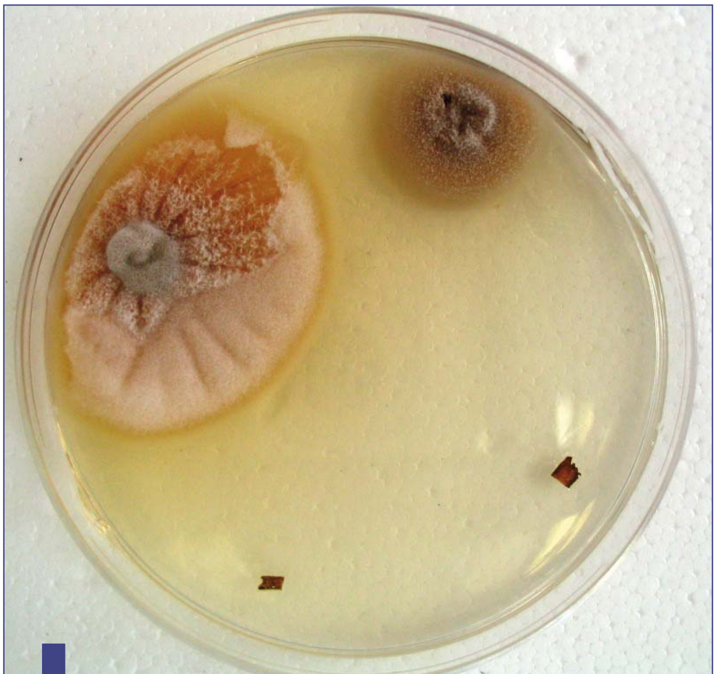
"Experience has shown that large releases often establish more successfully, but there are also plenty of examples where establishment has been achieved through single pairs (e.g. the broom pysllid, *Arytainilla spartiophila*), so 'Allee effects' may be over-rated," suggested Simon. Experience has also shown that it is usually best to spread risk through making many small releases than putting all your eggs in one basket.

Small populations may also be subject to genetic problems, for example they can lose genetic diversity or bad genetic traits can become more common. Also when organisms are reared for many generations under lab conditions they can become adapted to these conditions and less able to survive out in the real world. No one is sure just how important these genetic problems are, but it is generally easy to avoid creating them in the first place. Ensuring that large, diverse, founder populations are used and avoiding extensive lab rearing are commonplace good practice.

Release strategies still tend to be based on common sense and practical experience. We can usually make a sensible guess as to the most robust life stage to release, best time of the year to make releases, and the optimal number to release. Likewise we can choose what we believe to be ideal release sites, provide some initial protection or supplementary food, or even improve the food quality of their host plants (by pruning or fertilising etc.). However, it is important to take an adaptive management approach, in other words, experiment a little and change our strategy if need be further down the track. The success rate for establishing insect biocontrol agents worldwide is estimated to be a respectable 60–70% (of all species released) and for recent releases in New Zealand this figure is over 90%. However, the success rate *per release* may be a lot lower: for a difficult species like heather beetle (*Lochmaea suturalis*), a mere 4% of all releases on the Central Plateau have established. "If we are to make further gains in this area then what we need is more experimental studies, plus more monitoring and reporting on what people have tried and the outcome," concluded Simon.

Endophyte Release Hypothesis

Harry Evans (CABI, UK) gave a thought-provoking paper on the Endophyte Release Hypothesis. The premise that biocontrol is based upon is that when plants arrive in exotic ecosystems they can become invasive if they become separated from their natural enemies and no longer have their restraining influence (the Enemy Release Hypothesis). If the weed is then reunited with its natural enemies it can be brought back into line. However, it is now being hypothesised that another more cryptic factor may be at play that allows plants to become more competitive when they have the opportunity to colonise new environments. All terrestrial plants have fungal endophytes, which may produce no visible symptoms. There is increasing evidence that endophytes and their host plants have co-evolved and often both gain from the association (which is known as symbiosis). The endophytes get protection and nutrients. The plant may have reduced growth in the short term, as a result of this sharing arrangement, but gains additional resistance to pests and diseases through compounds the endophytes produce, and therefore increased fitness in the longer term.



Endophytes isolated from old man's beard in New Zealand.

If a plant becomes separated from its co-evolved endophytes (which for dicotyledonous plants is likely if they are introduced to new places as seeds) it may grow better because nutrients are no longer being siphoned off, as long as the plant is able to repel any pests and diseases it encounters in a new environment. New associations are unlikely to be as damaging to a plant as traditional ones, which have had time to get such exploitation down to a fine art. "Surveys have shown that Japanese knotweed (*Fallopia japonica*) in urban situations in the UK, where is has become a serious weed, is virtually free of endophytes, whereas in Japan it is loaded with them," reported Harry.

A plant without its endophytes is likely to be highly susceptible to its old foes, and this may explain why sometimes even the release of a single biocontrol agent can quickly bring a weed to its knees. "This could be why the rubber-vine (*Cryptostegia grandiflorum*) was quickly stopped in its tracks in Australia by the introduction of a rust (*Maravalia cryptostegiae*) despite the fact that such disease outbreaks have never been seen in its native range (Madagascar)," explained Harry. Other times when biocontrol is less successful it may be because the plant has not lost all its endophytes or has managed to aquire some locally.

We hope to be able to explore the role of endophytes in biocontrol in New Zealand in coming years.

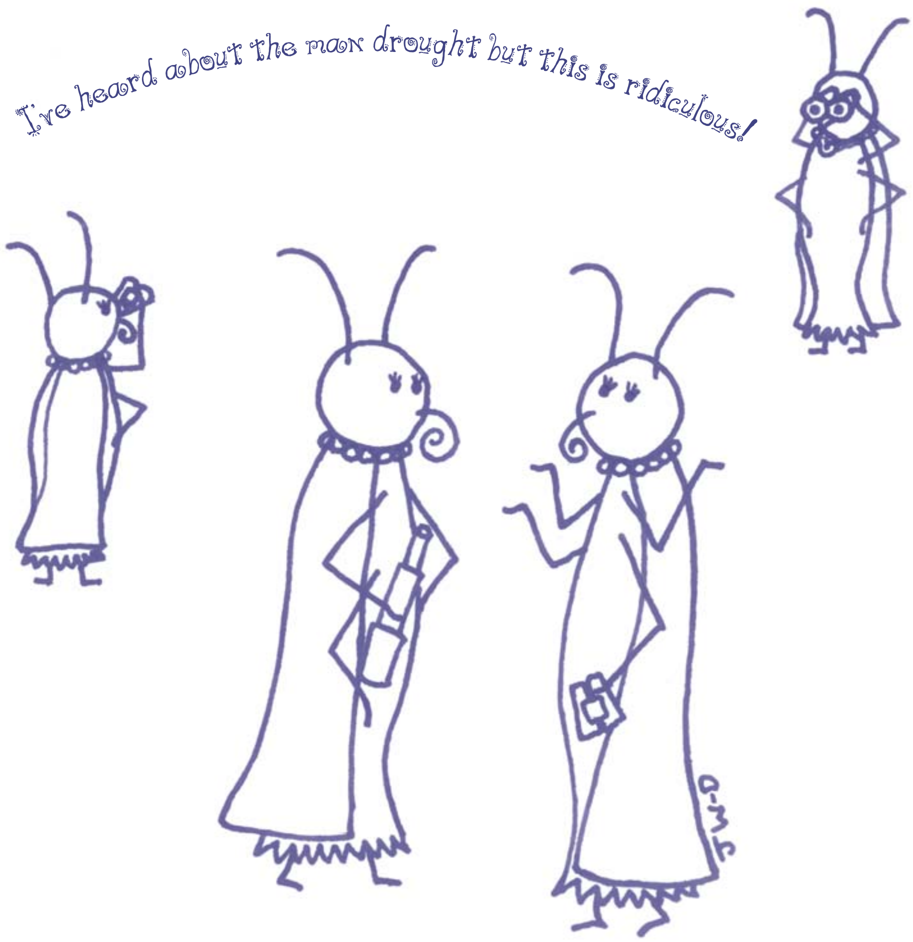
Sterilising Insects for a Good Cause

Sometimes when we are trying to host-test insect biocontrol agents we run into problems because the insects behave abnormally in confinement as the cues they use to discriminate are compromised, and outdoors open-air tests are needed to provide more realistic information. However, sometimes it is not possible to undertake such host-testing in a country where the insect naturally occurs or has been approved for release. This may be because test plants are not available or will not grow satisfactorily there, or regulations prohibit importation of the plant or restrict it from being taken outdoors, or it would take too long to work through. Other times there is not the infrastructure or personnel to undertake the work in a foreign country and it is not feasible or safe to send someone in to do the work.

At times like this the thought of being able to find a way of safely doing such field-testing at home becomes very appealing! No biocontrol scientist in their right mind wants to promote biocontrol agents that are not safe, but equally they do not want to walk away from agents that they suspect are indeed safe, but just can't prove it. One possible technique that could then come into play involves exposing insects to radiation that renders their offspring infertile. The F1 sterility technique, as it is known, can be used for moths and butterflies, bugs, and possibly some mites. It has been used to control unwanted insect pests, such as the painted apple moth (*Teia anartoides*), here in New Zealand. Large numbers of treated males were released so they could mate with any females that had managed to survive the aerial spraying programme, so the chances of females finding a mate that could help her to produce viable offspring were reduced.

Jim Carpenter (USDA, USA) spoke about a project to see if the F1 sterility technique could be a way of coping with unwanted non-target damage by a moth in Florida. *Cactoblactis cactorum* is a highly successful biocontrol agent for controlling invasive cactus (*Opuntia* spp.), but it has arrived in Florida where it is unwelcome because it attacks desirable cactus species. American scientists are exploring whether the sterile insect technique could be used to stop, or at least slow the spread of the moth to *Opuntia*-rich areas of the Western United States and Mexico, and preliminary results look promising. They may also be able in future to use reproductively inactivated moths to confirm which *Opuntia* species are at risk, and the moth's likely potential geographical range.

While to date the F1 sterility technique has become an accepted way of managing insect pests, its potential as a technique for host-testing biocontrol agents remains largely untapped. Another US scientist, Jim Cuda (University of Florida), explained that they are looking at whether this technique can be used for a potential agent for Brazilian peppertree (*Schinus terebinthifolius*). They are also exploring another possible approach with another potential agent that involves releasing only unmated females. Before these techniques are likely to gain widespread acceptance, further work needs to be done to check that they do not provide misleading results because the behaviour of the insects is influenced in some way, and that 100% sterility can be guaranteed. Even then F1 sterility may only be used as a last resort because of the expense involved in producing the enormous numbers of individuals that are needed for open-air field trials.



Unable to Go the Whole Hog

Sometimes classical biocontrol is just not a happening thing. Very occasionally surveys for potential natural enemies fail to uncover any suitable candidates, and this was recently the case for giant hogweed (*Heracleum mantegazzianum*). This overgrown member of the parsley family is a problem weed in Europe and is currently a minor weed in New Zealand. It is considered a public health hazard because if you get some of its sap on your skin you can get end up with nasty painful dermatitis. Marion Seier from CABI gave a paper explaining that surveys of the plant they had undertaken in its native range, the Western Caucasus mountains, did not uncover any natural enemies that were sufficiently host-specific to be considered for control of the plant in Europe. Given that no classical biocontrol programme for a weed has yet been implemented in Europe it would not seem appropriate to kick off with a controversial one, where other non-target plants may suffer some damage.

"The lack of monospecific natural enemies could be to do with past glaciation events in the area during the Pleistocene," suggested Marion. The Caucasus is a recognised hot spot for biodiversity. The key reason for high biodiversity in the Caucasus mountains is that they border two glacial refugia. Normally when climate changes occur, such as during glaciation, many species will move to stay in areas of compatible climate and ecology. However, this isn't so easy when you have major barriers like mountains to contend with! During glaciations in the Caucasus these species were forced to retreat into small refugia, where they came under strong pressure to hybridise and adapt to the new conditions that had been thrust upon them. During interglacial periods the new populations from the two refugia would have been able to move out and come back together again. So what we have is a dynamic scenario with populations evolving, mingling, hybridising and segregating, which has favoured more generalist natural enemies over specialists which would have always been two steps behind.

"So if this hypothesis is correct it looks like the best hope now for giant hogweed is to explore the possibility of an inundative approach using a mycoherbicide," concluded Marion.

Buddleia Weevil Blooms

Since its first release near Rotorua, the buddleia leaf weevil (*Cleopus japonicus*) has been liberated in four other plantation forests around the North Island: Kinleith, Lake Taupo, Esk Forest in Hawke's Bay, and Rawhiti Forest Farm near Ohope. These locations were chosen to cover the range of climates the weevil might encounter in buddleia-infested areas of New Zealand and thus provide a good opportunity to determine its establishment and spread in the field.

Early signs show the buddleia leaf weevil is doing well at all sites. Feeding damage to buddleia plants close to the release point is already considerable, with the weevil feeding on both new and old foliage. "Its characteristic feeding damage has been easy to find and at one site weevils have already spread over 100 metres," reports Ensis entomologist Michelle Watson. Ensis staff are holding back on the champagne, however, until the weevil has survived its first New Zealand winter and populations begin to grow next spring.

The buddleia leaf weevil was also released in a small field trial where native and exotic plant species were planted alongside buddleia. The results of this trial support the host-specificity testing in the laboratory that showed the weevil is host-specific.

Ensis Forest Biosecurity and Protection

Buddleia leaf weevil.

Ensis is continuing to mass-rear the weevil and anyone interested in a release should contact Michelle Watson on 07 343 5729.

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

Plant Pathologists Gang Up on Weeds

There were many bright ideas proposed for recruiting pathogens in the war against weeds at the VIIIth International Bioherbicide Group (IBG) Workshop, which was attended by more than 30 scientists from all over the world. For example, tobacco plants can apparently be used to mass-produce a highly effective, virus-based bioherbicide against tropical soda apple (*Solanum viarum*), and dripper lines can be used in glasshouses to distribute a bioherbicide effective against the parasitic weed *Orobanche*. In case anyone has forgotten, a bioherbicide is an herbicide in which the active ingredient is a living organism (e.g. fungi, bacteria, viruses).

Despite the French location, there was a distinctly Kiwi flavour to the meeting as it was organised by Jane Barton (contractor to Landcare Research), Graeme Bourdôt and Geoff Hurrell (AgResearch). Jane was not able to attend the workshop, but Graeme and Geoff managed the event on the day and also gave presentations, as did Nick Waipara.

Graeme summarised the results of field experiments comparing the efficacy of two chemical herbicides (MCPA and MCPB) against giant buttercup (*Ranunculus acris*) with a bioherbicide based on the fungus *Sclerotinia sclerotiorum*. Bioherbicides are generally perceived to be more variable in their ability to damage target weed populations in the field than conventional herbicides, which can make research into natural methods seem less attractive to potential investors. Graeme showed that the synthetic herbicides also gave very variable results in the field, and that "on average, a *Sclerotinia*-based bioherbicide could be expected to be more effective against giant buttercup in dairy pastures than MCPB and almost as effective as MCPA".

International plant pathologists unite!

Geoff Hurrell's talk was titled "*Chondrostereum purpureum* is an effective biocontrol agent for gorse (*Ulex europaeus*)". He summarised results from a field trial in which the silver leaf fungus was applied to decapitated stumps of gorse bushes. As has been shown in earlier field trials, silver leaf fungus is slow-acting, but by 17 months after treatment more than half (56%) of the treated gorse plants were dead and the surviving plants were less vigorous than the controls.

Nick gave a presentation on his and other Landcare Research staff efforts to find and select particularly aggressive strains of *Colletotrichum* and *Phoma* species that might be used against a range of weeds, especially barberry (*Berberis* spp.) and old man's beard (*Clematis vitalba*). He explained that while they successfully obtained over 50 isolates of each fungus from a range of weeds in New Zealand, they were yet to find one aggressive enough for development as a bioherbicide. "But it's early days yet," said Nick.

Other talks were given that were of relevance to New Zealand:

- Chinese researchers have found a fungus (*Nimbya alternantherae*) that is effective against alligator weed (*Alternanthera philoxeroides*) and they have successfully isolated the toxin responsible.
- Alan Wood (ARC-Plant Protection Research Institute) has developed a clever and economical way to apply a bioherbicide to *Acacia* trees in South Africa. This involves a very cheap and simple formulation that could be effectively applied to trees with a chisel.
- Maurizio Vurro (Institute of Sciences of Food Production, Italy) talked about more sophisticated technology involving genetic tools for tracking biocontrol agents. This is relevant to New Zealand because several pathogens with potential as bioherbicides here are widespread and have broad host ranges (e.g. the silver-leaf fungus and *Sclerotinia*) and if they are ever commercialised it would be useful to be able to distinguish fungus that has been deliberately applied from fungus that occurs naturally.

Most of the other talks focused on specific methods for mass-producing particular bioherbicides, and the ongoing battle against parasitic weeds (*Orobanche* and *Striga* species). We are very fortunate in New Zealand to not have serious problems with these parasitic plants (yet). They take water and nutrients from many crop-plants causing serious decreases in yield elsewhere in the world. According to the *Flora of New Zealand*, we don't have *Striga* species here and we only have one species of *Orobanche*, *O. minor* (broomrape). This species is mostly a problem on clover (*Trifolium* spp.) in pasture, but it has a wide host range that includes some crop plants in the Apiaceae family (this family includes carrots, parsnips and parsley) and native plants (e.g. *Brachyglottis, Pittosporum* and *Coprosma* species). It is therefore reassuring to know there is research underway overseas in case we need it in the future.

Overall, the workshop was deemed very worthwhile and IBG members voted to continue to meet every two years. The next one will be held in Florida in 2009.

Spring Activities

There are quite a few biocontrol activities that you might need to plan for this spring, such as:

Broom psyllids (*Arytainilla spartiophila*)

- Check release sites. From mid-spring look on new growth for the pink to orangey-brown nymphs, which later in the spring become brown-winged aphid-like adults. If you come across an outbreak, plants may covered in sticky droplets and have blackened stems, greyish, mottled foliage, and dead or blackened leaf buds. Please let us know if you come across such an outbreak.
- Move psyllids around by cutting material with nymphs on. It is best not to shift adults as they are quite fragile and may be too old to lay many eggs.

Broom seed beetles (*Bruchidius villosus*)

- Check release sites. Look for adults in the spring congregating on broom flowers or for eggs on the pods.
- Move beetles around. Collect them by either beating broom flowers with a stick over a sheet and sucking the beetles up with a pooter or putting a large bag over flowers and giving them a good shake. Alternatively, wait and harvest infested pods when they are mature (blackish-brown) and beginning to burst open.

Gorse soft shoot moth (*Agonopterix ulicetella*)

- Check release sites. Aim to visit sites in late November or early December when the caterpillars are about half-grown. Look for webbed or deformed growing tips with a dark brown or greyish-green caterpillar inside. Please let us know if you find an outbreak or this agent anywhere that you didn't expect.
- Shift moths around by harvesting branches or even whole bushes.

Gorse colonial hard shoot moth (*Pempelia genistella*)

- Check release sites. Look in late spring when the green-and-brown striped caterpillars and their webs are at their largest and before plants start to put on new growth. Please let us know if you find any.
- Shift moths around. If the moths are present in good numbers harvest branches with webs in late spring when large caterpillars or pupae are present.

Ragwort crown-boring moth (*Cochylis atricapitana*)

- Check release sites. Look for thickened stems and bunched leaves or rosettes with damaged centres and black frass. To see the caterpillars you may need to pull apart damaged plants. The caterpillars are creamy-white with black heads that become brown or tan when they are older. Please let us know if you find any.

Ragwort plume moth (*Platyptilia isodactyla*)

- Check release sites. Look for plants that have wilted or blackened or blemished shoots. Damaged shoots will also have holes in the stems and an accumulation of debris on silken webbing. You will need to pull some damaged plants apart to see the caterpillars, which are initially pale and later become green and hairy. Please let us know if you find any.

Ragwort plant showing damage caused by the ragwort plume moth.

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, first release made in early 2007 and it is hoped widespread releases will begin later in 2007.
Bridal creeper rust (*Puccinia myrsiphylli*)	Rust fungus, self-introduced, first noticed in 2005, widespread, appears to be causing severe damage at some sites.
Broom gall mite (*Aceria genistae*)	Gall former, was imported recently but not considered a new organism to NZ, it is hoped releases can begin in 2008.
Broom leaf beetle (*Gonioctena olivacea*)	Foliage feeder, recently approved for release by ERMA, first releases made in 2006/07 and it is hoped widespread releases will begin in 2007/08.
Broom psyllid (*Arytainilla spartiophila*)	Sap sucker, becoming more common, slow to disperse, two damaging outbreaks seen so far, impact unknown.
Broom seed beetle (*Bruchidius villosus*)	Seed feeder, becoming more common, spreading well, showing potential to destroy many seeds.
Broom shoot moth (*Agonopterix assimilella*)	Foliage feeder, recently approved for release by ERMA, and it is hoped releases can begin in 2008.
Broom twig miner (*Leucoptera spartifoliella*)	Stem miner, self-introduced, common, often causes obvious damage.
Californian thistle flea beetle (*Altica carduorum*)	Foliage feeder, released widely during the early 1990s, not thought to have established.
Californian thistle gall fly (*Urophora cardui*)	Gall former, rare, galls tend to be eaten by sheep, impact unknown.
Californian thistle leaf beetle (*Lema cyanella*)	Foliage feeder, rare, no obvious impact, no further releases planned.
Californian thistle rust (*Puccinia punctiformis*)	Systemic rust fungus, self-introduced, common, damage not usually widespread.
Californian thistle stem miner (*Apion onopordi*)	Stem miner, will attack a range of thistles, recently approved for release by ERMA, and it is hoped releases can begin in 2007/08.
Green thistle beetle (*Cassida rubiginosa*)	Foliage feeder, will attack a range of thistles, recently approved for release by ERMA, and it is hoped releases can begin in 2007/08.
Echium leaf miner (*Dialectica scalariella*)	Leaf miner, self-introduced, becoming common on several *Echium* species, impact unknown.
Gorse colonial hard shoot moth (*Pempelia genistella*)	Foliage feeder, limited releases to date, established at three sites, impact unknown but obvious damage seen at one site, further releases planned.
Gorse hard shoot moth (*Scythris grandipennis*)	Foliage feeder, failed to establish from small number released at one site, no further releases planned due to rearing difficulties.
Gorse pod moth (*Cydia succedana*)	Seed feeder, becoming more common, spreading well, showing potential to destroy seeds in spring and to a lesser extent in autumn.
Gorse seed weevil (*Exapion ulicis*)	Seed feeder, common, destroys many seeds in spring.
Gorse soft shoot moth (*Agonopterix ulicetella*)	Foliage feeder, becoming common in Marlborough and Canterbury with some impressive outbreaks, impact unknown.
Gorse spider mite (*Tetranychus lintearius*)	Sap sucker, common, often causes obvious damage, but persistent damage limited by predation.
Gorse stem miner (*Anisoplaca pytoptera*)	Stem miner, native insect, common in the South Island, often causes obvious damage, lemon tree borer has similar impact in the North Island.
Gorse thrips (*Sericothrips staphylinus*)	Sap sucker, gradually becoming more common and widespread, impact unknown.
Hemlock moth (*Agonopterix alstromeriana*)	Foliage feeder, self-introduced, common, often causes severe damage.

Hieracium crown hover fly (*Cheilosia psilophthalma*)	Crown feeder, only one release made so far and success unknown, rearing difficulties need to be overcome to allow widespread releases to begin.
Hieracium gall midge (*Macrolabis pilosellae*)	Gall former, widely released and has established but is not yet common at sites in both islands, impact unknown but very damaging under laboratory conditions.
Hieracium gall wasp (*Aulacidea subterminalis*)	Gall former, widely released and has established but is not yet common in the South Island, impact unknown.
Hieracium plume moth (*Oxyptilus pilosellae*)	Foliage feeder, only released at one site so far, impact unknown, further releases will be made if rearing difficulties can be overcome.
Hieracium root hover fly (*Cheilosia urbana*)	Root feeder, limited releases made so far and success unknown, rearing difficulties need to be overcome to allow widespread releases to begin.
Hieracium rust (*Puccinia hieracii* var. *piloselloidarum*)	Leaf rust fungus, self-introduced?, common, may damage mouse-ear hawkweed but plants vary in susceptibility.
Heather beetle (*Lochmaea suturalis*)	Foliage feeder, released widely in Tongariro National Park, established at five sites there and three sites near Rotorua, severe localised damage seen already, especially at Rotorua.
Lantana plume moth *(Lantanophaga pusillidactyla)*	Foliage feeder, self-introduced, distribution and impact unknown.
Mexican devil weed gall fly (*Procecidochares utilis*)	Gall former, common, initially high impact but now reduced considerably by Australian parasitic wasp.
Mist flower fungus (*Entyloma ageratinae*)	Leaf smut, common and often causes severe damage.
Mist flower gall fly (*Procecidochares alani*)	Gall former, now well established and common at many sites, impact not yet known.
Nodding thistle crown weevil (*Trichosirocalus* sp.)	Root and crown feeder, becoming common on several thistles, often provides excellent control in conjunction with other nodding thistle agents, identity is being checked.
Nodding thistle gall fly (*Urophora solstitialis*)	Seed feeder, becoming common, often provides excellent control in conjunction with other nodding thistle agents.
Nodding thistle receptacle weevil (*Rhinocyllus conicus*)	Seed feeder, common on several thistles, often provides excellent control of nodding thistle in conjunction with the other nodding thistle agents.
Old man's beard leaf fungus (*Phoma clematidina*)	Leaf fungus, common, sometimes causes obvious damage especially in autumn, but can exist as a symptomless endophyte.
Old man's beard leaf miner (*Phytomyza vitalbae*)	Leaf miner, common, laboratory studies suggest it is capable of stunting small plants, one severely damaging outbreak seen so far.
Old man's beard sawfly (*Monophadnus spinolae*)	Foliage feeder, limited widespread releases have been made, establishment is looking unlikely.
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 crown-boring moth (*Cochylis atricapitana*)	Stem miner and crown borer, widespread releases now underway and establishment success unknown.
Ragwort flea beetle (*Longitarsus jacobaeae*)	Root and crown feeder, common in most areas, often provides excellent control in many areas.
Ragwort plume moth (*Platyptilia isodactyla*)	Stem, crown and root borer, widespread releases now underway, appears to have established at one site so far.
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.

Further Reading

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If you need assistance in locating any of the above references please contact Lynley Hayes.

What's New in Biological Control of Weeds? issues 11–40 are available from the Landcare Research website (details below).

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