What's New In Biological Control Of Weeds?

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What's Inside:

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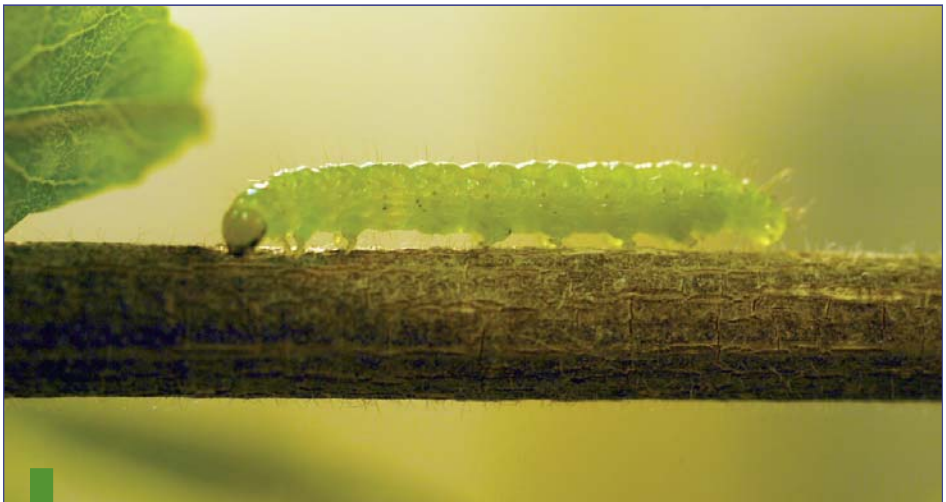
Landcare Research Manaaki Whenua

Colombian Courier Delivers Precious Package

Thanks to the successful execution of a cunning plan we have made a breakthrough in our problem-plagued banana passionfruit programme (*see Bring On the Passion Killers, Issue 29*). Our biggest obstacles have been negotiating the red tape involved in transporting live insects from Colombia to New Zealand and getting a shipment here safely. Two previous shipments of a moth (*Pyrausta perelegans*) that feeds on the foliage, flowers, and fruit of banana passionfruit were delayed, and they arrived in such poor condition that they ended up being unusable. It took a year, and another visit by Hugh Gourlay to Colombia, to complete the paperwork and be able to make a third attempt. This time we decided that our best bet was for someone to hand-carry them all the way. Victoria Barney, of the Centro Internacional de Agricultura Tropical in Colombia, who has been an essential contact in this project, volunteered for the job, and in June made the special trip.

There were a few nervous moments at the New Zealand border and several long phone calls between Hugh and border officials, but the strategy paid off and the shipment arrived safe and sound – hooray! Vicki stayed on for a few days and Hugh took her sightseeing around Banks Peninsula. "I showed Vicki how well banana passionfruit grows in New Zealand and she was stunned by how rampant it can get," said Hugh.

Although partial to all parts of the plant, caterpillars can survive solely on foliage. "They do eat a lot," commented Lindsay Smith, who is tending them in quarantine. Young larvae also burrow into stems and kill off the tips. Now we have managed to build up numbers we can afford to sacrifice a few and can therefore start host testing. "We will focus on larval starvation tests as the female moths are not very discerning about where they lay eggs," Hugh said. "They dot them around the cages as well as on the plants." Some moths do this when confined to cages



A banana passionfruit specialist recently imported from Colombia (*Pyrausta perelegans*).

but are not so foolish in a more natural setting.

The plant list for host-specificity testing is quite short. The passionfruit genus *Passiflora* is made up of three subgenera: *Tacsonia*, which includes all the weedy species, *Passiflora*, which includes the commercially grown passionfruit (*P. edulis*), and Tetrapathaea, which includes the native passionfruit, kōhia (*P. tetrandra*). Field observations by experts in Colombia and testing in Hawai'i suggest that the moth only attacks species in the subgenus *Tacsonia*. It would be ideal to have one agent that strikes several weedy passionfruit species! However, if it attacks either the native or commercially grown passionfruit, then, despite the efforts put in to get this far, we will have to reject it, like we did the leaf spot fungus (*Septoria sp.*).

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

Victoria Barney admiring the Colombian national passionfruit which is farmed for its fruit.

New Look Newsletter
Landcare Research has recently refreshed its brand. In keeping with these changes we have given the newsletter a new look. We hope you like it!

Things To Do This Summer

We aren't the only ones looking forward to warmth and sunshine; many biocontrol agents will be gearing up for a busy summer too! So dig out the sun hat and take part in some of these activities:

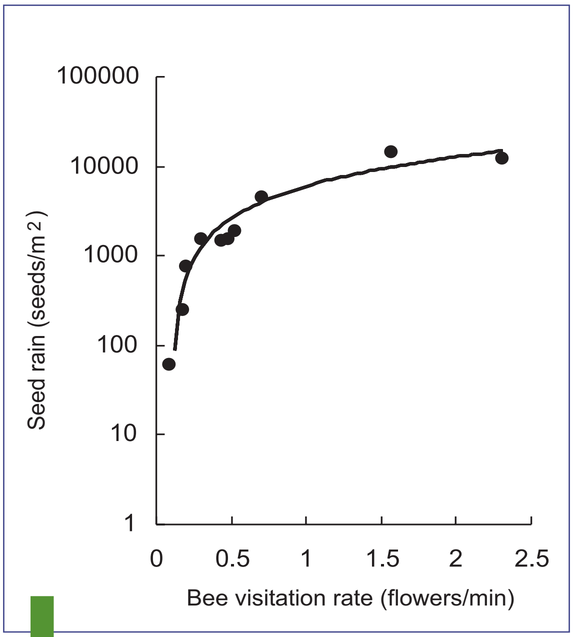
- Checking old man's beard saw fly (*Monophadnus spinolae*) release sites. We are still looking forward to our first confirmed sighting of these in the field so keep your eyes peeled. Look out for leaves with semicircular incisions along the margin or which have been completely skeletonised, black balls of frass, and the white caterpillar-like larvae.
- Checking gorse soft shoot moth (*Agonopterix ulicetella*) release sites. Get in quick as the best time to look is early December when the caterpillars are quite large but have not yet pupated. Look for dark brown or greyish green caterpillars inside webbed or deformed growing tips.
- Checking Portuguese gorse thrips (*Sericothrips staphylinus*) release sites. Gorse thrips can be confused with flower thrips (*Thrips obscuratus*) so look for them when gorse isn't flowering. Gorse thrips favour new growth so begin your search there, and use a hand lens. If you can't see any try gently beating some foliage over a white sheet.
- Checking hieracium gall midge (*Macrolabis pilosellae*) release sites. Look for plants with swollen and deformed leaves caused by larval feeding.
- Harvesting broom seed beetles (*Bruchidius villosus*). It is easy to redistribute beetles while they are still inside the pods, but avoid green ones as the beetles will not be quite ready. You need to hold off until the first pods have started to burst and then get straight into it.
- Harvesting cinnabar moth (*Tyria jacobaeae*). Populations of cinnabar moth are becoming harvestable in some parts of New Zealand where previously it has been rare. This insect can be difficult to establish in some areas and it is not always obvious why. If you have had no luck establishing the caterpillar in a particular area previously then it's probably best to try releasing them somewhere new.

Remember to read up the relevant pages in The Biological Control of Weeds Book before embarking on any of these activities, and let us know how you get on!

Bees Busted

Last year we reported that honeybees are the most important pollinator of broom flowers (see *The Broom and the Bees*, Issue 33). In fact, these busy insects, and to a lesser extent their partner-in-crime, bumble bees, appear to be an important factor in the spread of the weed! This year we investigated how the amount of seed produced by broom relates to pollinator activity.

Data collected from four sites in the North Island and three in the South Island show a strong correlation between honeybee visitation rate and broom seed rain. "The amount of seed produced varied by two orders of magnitude between sites, but was always closely correlated with the honeybee flower visitation rate," explained Quentin Paynter. At a site where honeybees were absent, and only bumblebees visited broom flowers about once every 10 minutes on average, we recorded the lowest seed fall (59 seeds/m^2). The highest seed fall was a mind-boggling 14,400 seeds/m^2 and was counted at a site where honeybees visited on average two flowers a minute.



The more bees visit flowers the more seed is produced.

After almost going cross-eyed counting seed it was light relief to follow bees and record their flower preferences. Our research shows that broom is not necessarily the top choice for honeybees, and that this varies throughout the flowering season. At Palmerston North honeybees commonly visited buttercup (*Ranunculus* sp.) flowers when broom was flowering. At Lincoln, broom accounted for only 18% of floral visits: earlier in the season, honeybees commonly visited kowhai (*Sophora* spp.), tree lucerne (*Chamaecytisus palmensis*) and shrubby germander (*Teucrium fruticans*) as well as broom. From mid-November onwards they favoured white clover (*Trifolium repens*) over broom at both Hanmer and Lincoln. Flax (*Phormium tenax*) was also popular at Lincoln. If broom decreases in future due to biocontrol these species could make up for the reduction in food honeybees currently gain from the weed. In fact, these other plant species may become more common due to the increased attention. "Broom is expected to decline slowly as biocontrol kicks in, so beekeepers will have an opportunity to plant alternative pollen sources to replace broom," said Quentin.

In a side experiment we looked at whether it is possible for the broom seed beetle (*Bruchidius villosus*) to inadvertently contribute towards broom spread. "We set up an experiment with sleeved, untripped broom flowers and were not surprised to find the flower-opening abilities of the beetle are virtually non-existent," said Quentin. This confirms our expectation that even though the beetle fossicks around in flowers it does not have an unwanted pollinating side-effect!

The situation in New Zealand mirrors that found by other studies, in that broom is reliant on honeybees and bumblebees for effective pollination, and the production of seed can be severely limited by the absence of pollinators. Quentin presented this work to the National Beekeepers Association of New Zealand conference last year. "The Association must have accepted our findings because they did not oppose our application to ERMA to release two new biocontrol agents for broom, unlike in the past," said Quentin (see *Broom Roundup*, page 4 this issue).

Renco Baars

Honeybee feeding on a kowhai flower.

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

Broom Roundup

Broom (*Cytisus scoparius*) has been the target of a biocontrol programme in New Zealand for over 20 years but the plant is still forming a big green blot on the landscape! In this article we introduce three new recruits in the war against this undesirable legume and look at why they are needed.

The old hands

Our first ally in the war on broom was the broom twig miner (*Leucoptera spartifoliella*). This tiny white moth is believed to have been accidentally introduced on ornamental broom plants from Europe. It was first recorded in 1950 and since then has spread throughout the country. The twig miner has a significant impact on broom in the spring in some areas, reducing growth, flowering, and plant longevity, especially when drought is also a factor. Unfortunately broom is usually able to regrow over summer when the twig miner is inactive.

The official start of broom biocontrol in New Zealand was in 1985 when the DSIR imported a population of broom seed beetles (*Bruchidius villosus*) from England. The small black beetles are now quite widespread and capable of destroying at least 80% of the seed crop.

The sap-sucking broom psyllid (*Arytainilla spartiophila*), was introduced from England in 1992. Some outbreaks are starting to occur but we have not yet seen any long-term impact from this agent, and suspect that predation by other insects (such as mirids) may prevent the psyllids from achieving their full potential. However, more studies are needed to clarify the situation.

Occasionally an endemic stem-feeding moth (*Anisoplaca ptyoptera*) and an exotic insect pest, the lemon tree borer (*Oemona hirta*), attack broom but are more commonly found attacking gorse (*Ulex europaeus*).

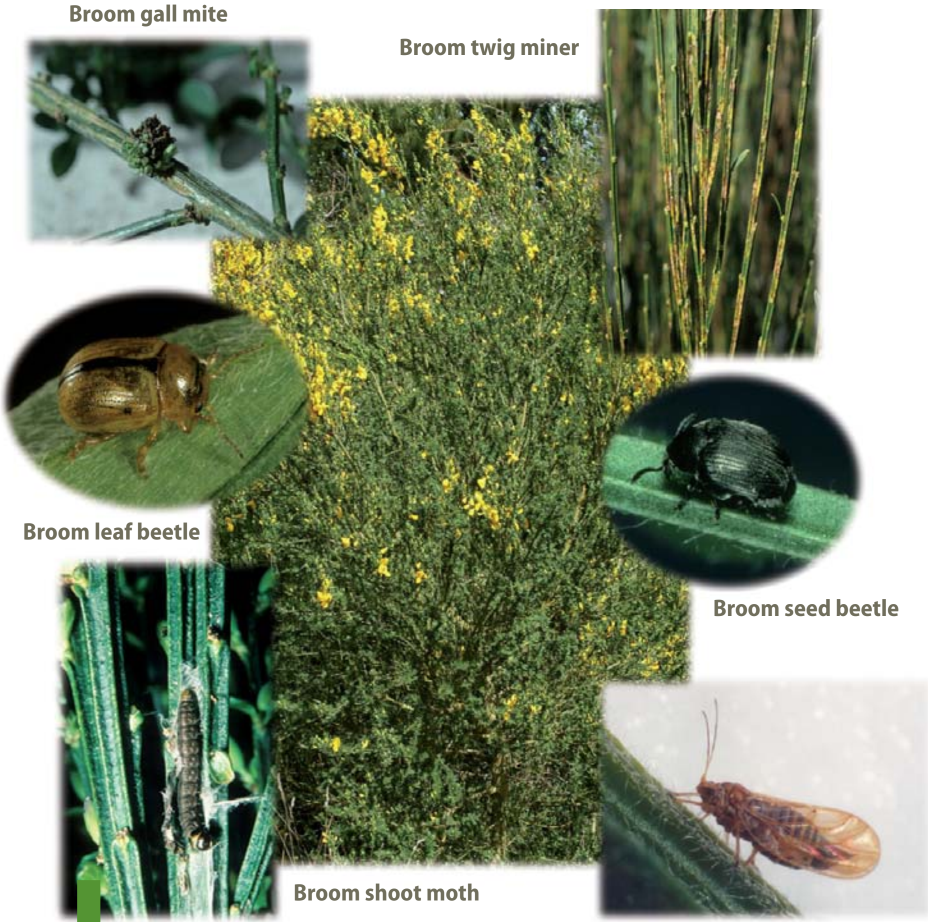
The new recruits

The first new agent is the broom leaf beetle (*Gonioctena olivacea)*. The small browny red adults feed on foliage and the crocodile-like larvae attack both leaves and stem tips. Newly hatched larvae are voracious feeders and their active period should coincide perfectly with broom regrowth after twig miner attack.

Another new agent, the broom shoot moth (*Agonopterix assimilella*), is a close relative of the gorse soft shoot moth (*Agonopterix ulicetella*). In both species damage is caused by the dark brown or greyish green caterpillars. Newly hatched broom shoot moth caterpillars bore into the stem where they spend winter. In spring they emerge and make themselves a tent, by tying together a couple of twigs with silk. From this base the caterpillars feed on the leaves and kill off stem tips by ringbarking them.

The third new agent, the broom gall mite (*Aceria genistae*), is so small it can't be seen with the naked eye. During winter the mites live in colonies inside the base of stem buds. In the spring, feeding by mites causes the buds to develop into deformed lumps that are 5–30 mm across. Many overlapping generations of mites live and feed in the galls over spring and summer. In late summer and autumn the galls start to wither and, taking this cue, the mites migrate to a new stem bud for the winter.

All three new recruits have major impacts on broom populations in their native



Broom biocontrol agents.

range. "The moth and beetle can strip plants bare, so no green growth remains!" marvelled Hugh. "By forming galls on successive years' growth the mites cause stunting, reduced flowering, and even kill whole bushes, and they do not mind shade." Like all biocontrol agents introduced into New Zealand the trio are likely to be able to perform even better here since they will be released from their own natural enemies.

The Environmental Risk Management Authority (ERMA) has recently approved an application by the Canterbury Broom Group to release the leaf beetle and shoot moth in New Zealand. Both agents may cause some damage to tree lucerne (*Chamaecytisus palmensis*) but it was judged an acceptable risk given the pressing need to control broom. The mite, *Aceria genistae*, did not need ERMA approval as it has already been recorded in New Zealand, but on gorse. Recent research shows that *Aceria genistae* includes a number of distinct strains, each of which is specific to one species of plant. We are certain that the mites we are introducing will only attack broom and are unlikely to interbreed with the resident strain.

We have had a few hiccups importing populations of the new agents into containment. We already had a small number of leaf beetles in quarantine but needed to augment them. Hugh visited the UK in April and May this year and brought some back along with some shoot moths. Unfortunately delays, during biosecurity clearance in New Zealand, caused all the beetles and most of the moths to succumb to dehydration. Quentin Paynter collected more leaf beetles from the UK and some gall mites from France in June. "To ensure their safety I hand-carried them back on the plane," said Quentin. Despite delays again at the border, the beetles made it through and are doing well. While Quentin's beetles still need to be rephased to Southern Hemisphere conditions, the other colony has been certified disease-free and formally identified, so they can now be removed from quarantine and mass-rearing can begin. We will import more broom shoot moths next year.

The gall mites have required personalised one-on-one treatment. The galls are often infested with other creatures, including predatory mites. To ensure a clean colony, Hugh and Quentin have had to meticulously transfer the microscopic mites, one at a time using a very fine pin, onto fresh plant material. "It may take up to a year for the galls to develop on plants. So it will be a while before we can take the mite out of quarantine and start mass-rearing," said Hugh.

We hope to make at least one release of one of the new agents this coming summer, probably the leaf beetle.

The Outlook

Broom models suggest biocontrol should be able to reduce the rate at which broom invades new areas and also cause areas already infested by broom to decline. It will still be many years before we have all the agents out there in good numbers to see if these predictions come true, but we are quietly confident. In addition, we have not yet exhausted all possible broom biocontrol agents, and there are others that are less well studied which could be revisited should the need arise.

The project to develop new agents for broom is funded by the Canterbury Broom Group thanks to a MAF Sustainable Farming Fund grant and contributions from The Forest Health Research Collaborative, and a national collective of regional councils nationwide and the Department of Conservation.

Report Card: Biocontrol of Broom Agents

Broom Seed Beetle	A hard worker not put off by the magnitude of its job. Likely to be appearing now in a broom patch near you to help stem the enormous shower of seeds.
Broom Psyllid	A secretive type that spends most of the year hiding away inside the stem, giving no clue as to its presence. Has managed a few spectacular shows but may be the new favourite food item for some predatory types.
Broom Twig Miner	A self-starter that works well without supervision. Initially hardworking but slackens off over summer allowing broom to regain the upper hand.
Broom Leaf Beetle	A good-looker with racing stripes that we hope will get off to a quick start.
Broom Shoot Moth	A happy camper that will inevitably be compared with its cousin the gorse soft shoot moth.
Broom Gall Mite	A shady character that we hope will be proof that good things come in small packages.
Areas Needing Improvement	The present agents are now widespread but are still not everywhere or necessarily in high enough numbers. We need broom foliage and stems to be harder hit especially during the summer when the twig miner is inactive.
Future Prospects	The three new agents should be able to supply the extra pressure needed. If not there are other less well known beasts out there which could be subjected to increased scrutiny and possibly deployed.

Potential Agents for Chilean Flame Creeper – Elusive but Worth Pursuing

Chilean flame creeper (*Tropaeolum speciosum*) is proving to be very secretive about its natural enemies. Not a single invertebrate or pathogen has been reported on the plant from its home range in Chile or in New Zealand. This is interesting given that the creeper is highly invasive in southern parts of New Zealand but is not very common in its native range. "Surely something helps to keep it in check at home?" mused Helen Harman, who recently completed a feasibility study on the prospects for biocontrol of the weed.

Chilean flame creeper's home range is restricted to the coastal Valdivian rain forest in Chile. "It is likely that no one has reported any natural enemies on the weed because it has not been well-studied, rather than because it is some sort of unpalatable super-plant!" said Helen.

Despite the lack of information about potential agents, Chilean flame creeper looks like a good target for biocontrol. The vines smother native vegetation and cut off light to ground-dwelling plants. The weed has excellent dispersal abilities; it takes advantage of birds to spread its seed and has the ability to resprout from fragments of root or stem. Unfortunately, the creeper can also happily grow in damp, salty, dry, warm or cool sites. In New Zealand it typically invades disturbed forests and shrublands and occurs in Stewart Island, Southland, and as far north as the Waikato. So far the weed is proving most problematic in Otago and Southland, but it may only be a matter of time before it becomes a concern in other regions too.

Because of Chilean flame creeper's ability to resprout it is difficult to control. Manual and chemical methods require regular follow-up or repeated applications. The thin, spindly nature of the vines make it difficult to use foliar sprays without damaging surrounding vegetation, and it can be difficult to find and treat isolated infestations that grow from bird-dispersed seed.

Luckily, the creeper has no close indigenous relatives in New Zealand. However, there are two other *Tropaeolum* species that have also escaped from gardens and naturalised here. These are the garden nasturtium (*T. majus*) and ladies' legs (*T. pentaphyllum*). Also, several ornamental varieties of *Tropaeolum* are cultivated by nurseries and home gardeners. "While these cultivated species need to be included in host range testing of potential agents, the lack of other close relatives reduces the risks of non-target damage, and should also keep host-testing costs down," commented Helen.

Some invertebrates and pathogens have been recorded on other *Tropaeolum* species in New Zealand and overseas. Unfortunately, none have obvious biocontrol potential as they are not very host specific. The only pathogen that may have promise as a classical biocontrol agent is a rust called *Uredo tropeaoli*, recorded from *T. aduncum* in the UK. However, this has also been reported from nasturtiums. Some pathogens reported from overseas might have potential as bioherbicides, but only if they can be found in New Zealand as it would be more expensive and difficult to develop a bioherbicide based on an exotic microbe.

Given that biocontrol would be ideal for managing Chilean flame creeper, it makes sense to proceed with surveys of the weed in both New Zealand and Chile to ferret out its elusive natural enemies.

This project is funded by the national collective of regional councils and the Department of Conservation. A full copy of the report is available from Lynley Hayes (hayesl@landcareresearch.co.nz).

K McCombs

Chilean flame creeper showing its attractive flowers and blue fruit.

Weed Biological Control Pays Off

A recent publication provides clear evidence that there are far-reaching benefits from using biocontrol to combat weeds. The Cooperative Research Centre for Australian Weed Management (Weeds CRC) commissioned an economic impact assessment of the 104 years of weed biocontrol activity in Australia. Over this period there have been many programmes, targeting weeds such as prickly pear cactus (*Opuntia* spp.), Paterson's curse (*Echium plantagineum*), and bridal creeper (*Asparagus asparagoides*). Enough data were available for an economic assessment of 29 programmes.

"A benefit-cost ratio of 23 to 1!"

Lorraine Edmunds

Cactoblastis larvae have decimated prickly pear cactus in Australia.

The research shows that over the past century weed biocontrol has cost Australia on average $4.3 million per year. "However, this pales in comparison to the annual return from weed biocontrol of $95.3 million. A benefit-cost ratio of 23 to 1!" said Weeds CRC CEO Dr Rachel McFadyen. For every $1 invested in biocontrol there is a return of $17.40 to agriculture in saved control costs and increased production, $3.80 to the wider community primarily from health benefits, and $1.90 to the government also from saved control costs.

Biocontrol programmes often have high set-up costs and, as we all know, a lot of money can be spent investigating and testing prospective agents that fail at the last hurdle. This loss is part of the nature of scientific research; there are often many failures and dead ends before you make a breakthrough. The report shows that the huge annual return was in fact produced by only 14 successful programmes. "Although unsuccessful biocontrol programmes cost $15 million this cost is totally eclipsed by the benefits from the successful ones," explained Rachel.

The positive gains from a few biocontrol programmes were under-represented due to lack of data. In some cases not enough information was recorded to properly evaluate the performance of the programme. Biocontrol of weeds frequently results in environmental and social benefits that can be hard to quantify in dollar terms. So in order to make informed decisions on the future allocation of funding, and even more clearly show that investment in weed biocontrol has provided exceptional benefits, it is important to collect data on these areas too. The authors of the report recommend that social and environmental impacts, as well as production impacts, of the target weed are assessed in detail prior to releasing any agents, that all research costs are recorded, and that the programme is regularly monitored and evaluated throughout the release and establishment of agents.

The report also reinforces that biocontrol is not a quick fix and takes persistence and patience. The duration of an individual programme can be decades. For example, the programme for prickly pear spanned 35 years, and scientists have been working on ragwort (*Senecio jacobae*) and Paterson's curse in Australia for 30 years.

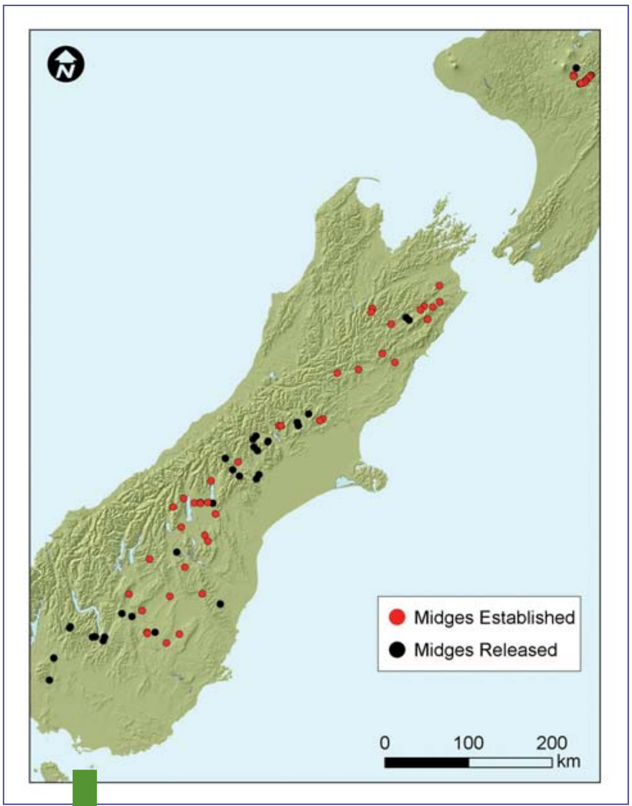
In New Zealand only the broom (*Cytisus scoparius*) biocontrol programme has been the subject of a cost–benefit analysis (see *Biological Control of Broom – Is It Worth It?* Issue 28). It would be great to see a similar analysis of all weed biocontrol programmes done here too!

Page, A.R.; Lacey, K.L. 2006: Economic impact assessment of Australian weed biological control. CRC for Australian Weed Management Technical Series # 10. 151 p.

Hieracium Heroes and Heartbreakers

The biocontrol project against hawkweeds (*Hieracium* spp.) continues to have highs and lows. Last summer Lindsay Smith had his nose to the ground scrutinising hieracium gall wasp (*Aulacidea subterminalis*) and gall midge (*Macrolabis pilosellae*) release sites. He has now recovered wasps from about a third of the release sites and confirmed midge establishment at 92% of the 51 sites he checked. Monitoring of the spread and density of these two species shows the gall midge lagging behind the gall wasp, but it is still early days! "At one site, where wasps have been established for several years, I found galled plants up to 160 m away," said Lindsay, "whereas the furthest distance I found midges from the original release point was 40 m." There is a good chance they have spread much further but it is harder to detect them. Data from five sites show the number of wasp larvae ranged from 7.5/m^2 to 122/m^2, and the highest midge density was just over 1 gall/m^2. Lindsay also made 19 new gall midge releases, bringing the grand total to 136 (see map).

We have received further shipments of both the root- and crown-feeding hoverflies (*Cheilosia urbana* and *C. psilophthalma)* but very few adults emerged. "I made the first, albeit rather small, release of the crown hoverfly in New Zealand and another small release of the root hoverfly," said Lindsay. We have had no luck at establishing a breeding population of either species and are still exploring whether it is possible to rear them in captivity. Unfortunately, Gitta Grosskopf, our colleague at CABI, Switzerland, has not made any breakthroughs either, and is only able to send us larvae from mated females collected from the field.



Hieracium gall midge release sites.

Likewise, attempts to breed the hieracium plume moth (*Oxyptilus pilosellae*) have been put on hold until we can get better advice. "The moths lay eggs in cages in Switzerland, but seem to get muddled up when we move them to the southern hemisphere," said Lindsay.

This project is funded by the Hieracium Control Trust, MAF Sustainable Farming Fund, and New Zealand Army.

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