WHAT'S NEW IN

Biological Control of Weeds?

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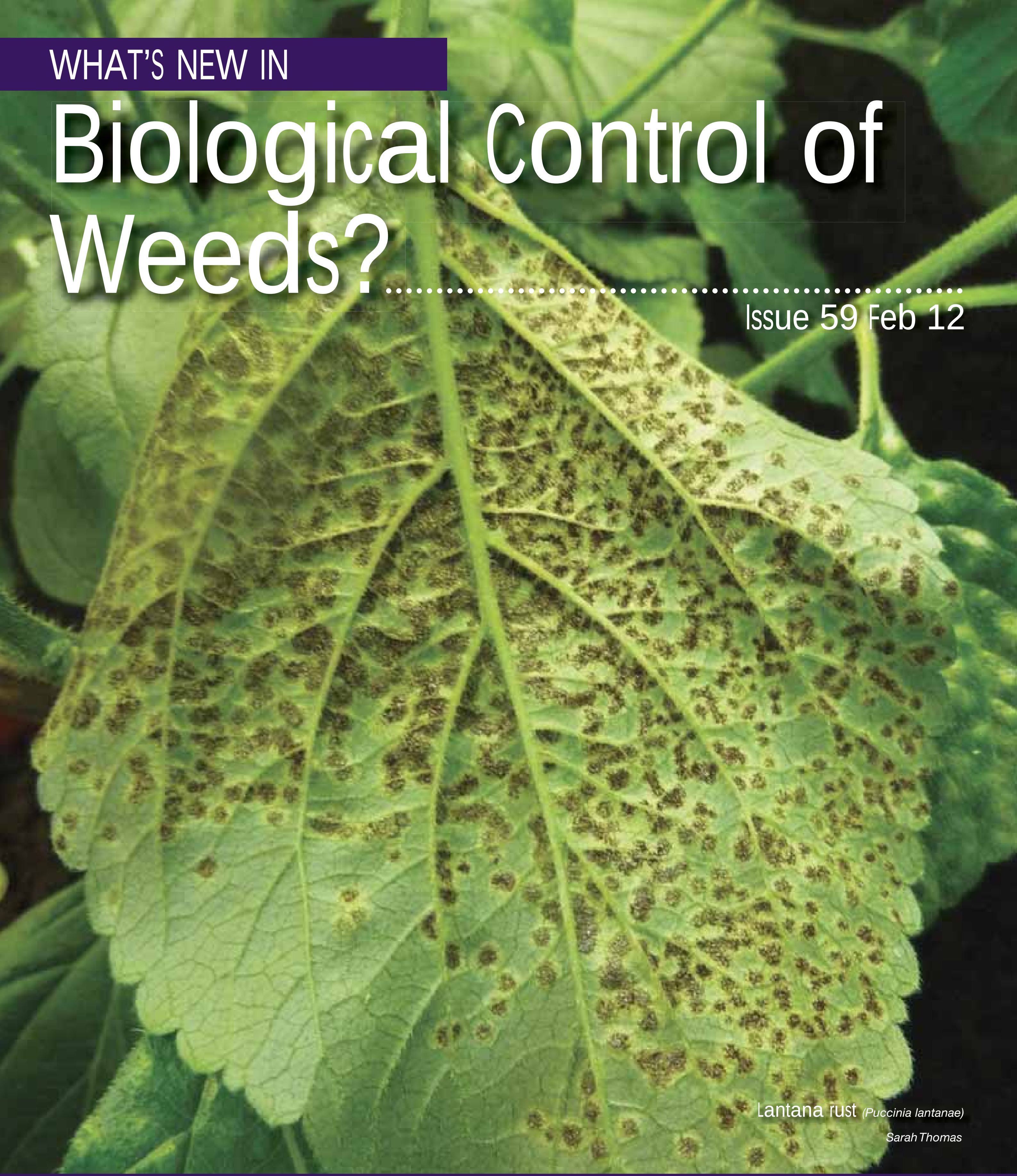

Lantana rust *(Puccinia lantanae)*

Sarah Thomas

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Landcare Research
Manaaki Whenua

Rusts to Tackle One of the World's Worst Weeds

Lantana (*Lantana camara*) is generally acknowledged to be one of the world's ten worst weeds. So far, in New Zealand problematic lantana infestations mostly occur in Northland, particularly around the Hokianga and Whangaroa harbours and Houhora – old settlement areas where they were planted as ornamentals long ago. However, lantana is also an emerging weed in the Auckland, Bay of Plenty and Wellington regions, and given that the plant has been reported causing problems in at least 47 countries worldwide, there is no room for complacency. So, biological control is being used against lantana in New Zealand as a "pre-emptive strike" rather than the more usual "last resort".

Insect biocontrol agents were first released against lantana overseas over 100 years ago. To date an impressive 39 insect species and 3 pathogens have been released against this weed in more than 40 countries. Agents have been more successful in some places than in others. This is partly because the weed is genetically diverse as a result of deliberate crossing of different *Lantana* species and subspecies for ornamental purposes. "When we started this project we knew it would be vitally important to match proposed biocontrol agents with New Zealand populations of lantana," explained Lynley Hayes, who is directing the project for Landcare Research. "We received a heads-up from Michael Day (Biosecurity Queensland), who has worked extensively on lantana biocontrol in Australia, that the insect agents were unlikely to thrive in New Zealand conditions, so we decided early-on to focus on pathogens." Note that a specialist lantana insect, a plume moth (*Lantanophaga pusillidactyla*) which feeds on the flowers, has self-introduced here but its impact is thought to be insignificant.

Fortunately, two rusts from South America seem to have good potential as biocontrol agents: *Prospodium tuberculatum* and *Puccinia lantanae*. *Pr. tuberculatum* is predominantly a leaf pathogen that causes leaf-death and defoliation. *Pu. lantanae* causes dead patches on stems, leaf stalks and leaves. It can cause systemic infection and is likely to trigger stem dieback as well. The climatic requirements of the two rusts differ slightly: *Pr. tuberculatum* is subtropical whereas *Pu. lantanae* is tropical. Consequently, we expect *Pr. tuberculatum* to be active across a wider area, including the more southern parts of lantana's range in New Zealand, while *Pu. lantanae* may be limited to the warmer and wetter areas of the far north. While the two rusts have not yet been observed together in the field, they can co-exist on the same lantana leaves in the glasshouse (see photo).

Lantana thrives in the tropical conditions of northern Australia and it became a problem there long before it caused any concerns here. While this was bad luck for the Aussies, it was good luck for us, as Dr Carol Ellison, Sarah Thomas and colleagues at CABI in the UK had already completed host range testing of *Pr. tuberculatum* by the time we took an interest in it. A strain of the rust from Brazil, that had been selected for its virulence towards one of the most invasive lantana populations in Australia (Brisbane common pink), was applied to 52 closely related non-target plant species. It did not cause any disease symptoms on any of the test plants. Indeed, the isolate was almost too specific as it only caused symptoms on 15 of the 40 Australian populations of the target weed tested. Still, this was the best isolate available, so the Aussies went ahead and released the pathogen in 2001.

Sarah Thomas

Lantana camara (Brisbane common pink) infected with both *Puccinia lantanae* (larger pustules) and *Prospodium tuberculatum.*

Five years later, when we decided we wanted biocontrol for lantana, we knew that *Pr. tuberculatum* would be specific enough for us, and just needed to check it could attack the lantana varieties that grow in New Zealand. We obtained lantana cuttings from four New Zealand populations (Whangaroa and Rawene, Northland; Newmarket, Auckland; and Tauranga, Bay of Plenty) and asked Michael Day and his colleague Natasha Riding to test their susceptibility. “The results were very positive: all of them were susceptible to the rust including, unexpectedly, the orange-flowered form,” reported Michael.

Meanwhile, lantana was proving a tough target in Australia. *Pr. tuberculatum* was slow to establish and spread initially, as drought conditions prevailed for several years in Queensland and New South Wales. The rust is now widespread but its impact is variable, which is due at least in part to the natural resistance of many lantana populations to this pathogen. In some places *Pr. tuberculatum* has still not established and where it has it mostly causes little damage, but it has been reported as damaging at some sites in New South Wales. The Australians, therefore, kept looking for further agents. This time we were on board as was South Africa, who also have a major problem with the weed. CABI suggested *Pu. lantanae* had good potential and conducted host range tests that included plant species of interest to all three countries.

Again we were lucky that the most promising *Pu. lantanae* strain from Peru could successfully infect lantana from all five populations from New Zealand that were tested (3 from Northland, 1 from Auckland and 1 from Tauranga) and also both colour forms (pink and orange). So then it was time to check what other species might be at risk. There are no New Zealand natives in the Verbenaceae (the family to which lantana belongs), so the plants of interest to us were: native species in other related families; naturalised species in the Verbenaceae family (six *Verbena* species have naturalised in New Zealand, and all of them have weedy tendencies); and, exotic species in this family of potential value in New Zealand.

Of the 40 plant species tested only three developed disease symptoms. Two of these, *Lippia alba* and *Phyla canescens* (both Verbenaceae), developed minor disease symptoms and a small number of spores. However, these plants are not present in New Zealand. The third and most susceptible non-target plant was *Verbena officinalis* (Verbenaceae), which is occasionally grown in New Zealand as an ornamental. Spores were produced by *Pu. lantanae* on two varieties of this plant, but in far fewer numbers than on the target weed, and further research showed that the rust could not persist on either variety of *V. officinalis*. It was concluded that *Pu. lantanae* might infect *V. officinalis* in New Zealand, but only where it is growing very close to infected lantana. If the rust is successful in controlling lantana then the chances of this “spillover” effect should reduce with time. From the test results we expect that damage to other ornamental *Verbena* hybrids will be minor, if it occurs at all. In the optimal conditions of laboratory tests, the two varieties of *V. officinalis* developed some disease symptoms but the other three *Verbena* species tested did not, and it is unlikely that infection in the field will be greater than that observed in the laboratory.

Since both *Pr. tuberculatum* and *Pu. lantanae* are highly host specific they look to be very promising biocontrol agents for New Zealand. Given that we have more reliable rain in the parts of New Zealand where lantana grows than in Australia, and our lantana varieties appear to be susceptible to the rusts, the factors that have limited *Pr. tuberculatum* in Australia should not apply here. In December Richard Hill and Jane Barton helped Northland Regional Council, on behalf of the National Biocontrol Collective, to submit an application to the Environmental Protection Authority (formerly ERMA) to introduce both rusts to New Zealand. Fingers crossed that permission will be granted and we will soon have two valuable tools to tackle lantana, before it can become one of the 10 worst weeds in New Zealand.

This project is funded by the National Biocontrol Collective. Richard Hill and Jane Barton are subcontractors to Landcare Research.

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First Moth Plant Agent Approved

An application by Waikato Regional Council, on behalf of the National Biocontrol Collective, to release the first biocontrol agent for moth plant (*Araujia hortorum*) was approved by the Environment Protection Authority just before Christmas. Adults of the reddish-black beetle (*Colaspis argentinensis*) feed on the leaves but the real damage is caused by the larvae, which attack the plant’s roots. This beetle is one of the most common natural enemies on moth plant in Argentina and it is thought to contribute to plant deaths seen there. Efforts are now being made to secure a colony of beetles from Argentina to allow mass-rearing and releases to get underway as soon as possible.

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New Zealand's Successful System for Approving Biocontrol Agents

New Zealand's system for introducing new organisms, including biocontrol agents, is highly regarded internationally. Many believe it to be the best and most comprehensive system in the world for considering new introductions. Over the past 14 years 22 species of biocontrol agents, targeting both plant and insect pests, have been approved for release in New Zealand and no applications have been declined (see table). Over the same period in many other countries, the rate of biocontrol agent introductions has slowed down. So what is it about our system that works so well? A paper considering this was presented last September at the 13th International Symposium on Biological Control of Weeds in Hawai'i. The paper was presented by Richard Hill and co-authored by staff at Landcare Research and the Environmental Protection Authority. The key findings are summarised below.

The New Zealand system is grounded in the Hazardous Substances and New Organisms (HSNO) Act 1996, and the conditions that regulate biocontrol agents came into force in 1998. The purpose of the Act is to protect the environment and human health and safety by managing the adverse effects of hazardous substances, including pesticides and explosives, and the introduction of exotic organisms, as well as genetic modification. The HSNO Act was administered by the Environmental Risk Management Authority (ERMA) until July 2011 when it was subsumed into the new Environmental Protection Authority (EPA).

The HSNO Act required the establishment of three bodies to help administer the Act. An Authority, which has between six and eight members, holds the powers of a commission of inquiry. Its decisions are legally binding and, while they can be challenged, they cannot be overturned, only referred back to the Authority for reconsideration. A Māori advisory board, Ngā Kaihautū Tikanga Taiao, helps ensure that the Treaty of Waitangi is taken into consideration when decisions are made. Finally an Agency facilitates applications, manages the regulatory process and makes recommendations to the Authority.

At the core of the New Zealand system is the principle that if the benefit of an introduction sufficiently outweighs the adverse effects, then that action should be allowed. This differs from many other jurisdictions worldwide where the quantum of risk is the primary factor considered, with little or no regard for potential benefit. The HSNO Act requires the Authority and the Agency to use recognised risk identification, assessment, evaluation, and management techniques in their consideration of applications. "As with all new things, when the HSNO Act was first introduced there was a period of adjustment as both applicants and Agency staff came to grips with the requirements," said Richard. However, the system has with time proved to be an efficient and effective statute for managing the introduction of new organisms.

Right from the beginning a methodology established by the Act provided a stable reference point by which applicants made their applications. It included a minimum set of standards and stated which issues should be addressed to produce a credible application. A range of technical guides were also produced to help applicants assess qualitative risks and benefits, among other topics. These documents clearly defined the standards for decision-making. Over time, as applications that have been through the process have formed a case history, some of the original guideline documents have been withdrawn as they are now considered too rigid to govern modern decision-making.

Another important reason for the success of the New Zealand system was the inclusion of strict time frames in the Act. Once an application has been made the Authority must make a decision. From the date of submission the Authority has a maximum of 100 working days in which to make its ruling. This time may only be extended by the permission of the applicant or if further information is required to make a rational decision – with the latter provision rarely being used. Having definite time frames like this is a huge advantage as delay cannot be used as a means of avoiding making decisions.

"The independence of the decision-making body is also an important feature of the New Zealand system," explained Richard. While the members are appointed by the government, the Authority is independent. The Act dictates that the Authority is autonomous and this means it is not susceptible to rogue political, economic or activist influences that might affect the decisions made.

The requirement for public participation has been a central part of the system from the beginning. The HSNO Act dictates that the application and evaluation process should be transparent and public. Applicants are encouraged to consult with affected groups, and in particular Māori, well before writing an application, to ensure all concerns are addressed. Applications to release biocontrol agents are also open for public submission for 30 working days. This means that the groups consulted have an opportunity to check whether their concerns have been adequately addressed, and gives others an opportunity to make a submission. If any submitter requests a public hearing in front of the Authority one must be held. This high level of public involvement, joined with the professionalism of the Agency and the independence of the Authority, has led to a high degree of trust between applicants, the public and the Authority members.

As the Agency has evolved it has worked to remove barriers to the lodging of applications. The Agency helps applicants to prepare successful applications by ensuring all the necessary conditions are met. The Agency has also been committed to making the application process easier and less expensive, which resulted in the application fee recently being halved. As case history has grown the Agency and Authority have become more confident in their capacity to assess the risk of applications, and have required less detailed supporting information, which has saved time and money. Recently the Authority also agreed to a broad approval allowing the importation of any invertebrate that is a prospective weed biocontrol agent into a containment facility for further study. Previously an application had to be made each time for each new species. This is a great cost-saving and streamlining initiative, and work is progressing to extend this approval to biocontrol agents for all pests.

However, while the regulatory process has been particularly helpful for weed biocontrol, others have found it more difficult to negotiate, and there is a danger that New Zealand could miss out on some potentially useful agents. Therefore, the EPA is aiming to make the application system even more accessible and efficient. Bringing potential applicants together will help to strengthen their voices as well as identifying and solving common issues. Also by helping everyone to better understand the issues involved in applications the Agency will continue to build trust between the public, applicants and the EPA. "This is a very public process in a very democratic society. People need to feel comfortable with the decisions made," concluded Richard. The EPA is also striving to make all the documentation as simple and readable as possible. In future, greater emphasis will also be placed on working with stakeholders outside the formal process. Interacting with government agencies can be bureaucratic, intimidating and slow, so working with people outside these formal channels will allow more freedom for discussion and genuine dialogue.

So far the transition from ERMA to the EPA, with its broader range of responsibilities, has been smooth, with the key factors that have made the New Zealand system for approving new organisms so effective remaining intact, as well as a commitment to further refinements and improvements. It is hoped this can continue into the future allowing New Zealand to manage threats to the environment through the use of safe beneficial organisms as effectively as possible.

Richard Hill is a contractor to Landcare Research.

Hill R, Campbell D, Hayes L, Corin S, Fowler S (in press). Why the New Zealand regulatory system for introducing new biological control agents works. Proceedings of the XIII International Symposium on Biological Control of Weeds, September 11-16 2011, Hawaii, USA.

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New organisms approved for release under HSNO

Target	Agents	Year of approval
Biocontrol of weeds		
Ageratina riparia	*Procecidochares alani*	2000
Pilosella spp.	*Macrolabis pilosellae*	2001
	Cheilosia urbana	
	Cheilosia psilophthalma	
Buddleja davidii	*Cleopus japonicus*	2005
Chrysanthemoides monilifera	*Tortrix* s.l. sp.	2005
Jacobaea vulgaris	*Cochylis atricapitana*	2005
	Platyptilia isodactylis	
Cytisus scoparius	*Agonopterix assimilella*	2006
	Gonioctena olivacea	
Cirsium arvense	*Cassida rubiginosa*	2007
	Ceratapion onopordi	
Tradescantia fluminensis	*Neolema ogloblini*	2008
Solanum mauritianum	*Gargaphia decoris*	2009
Nassella neesiana	*Uromyces pencanus*	2011
Tradescantia fluminensis	*Lema basicostata*	2011
	Neolema abbreviata	
Araujia hortorum	*Colaspis argentinensis*	2011
Biocontrol of insect pests		
Mealy bug	*Pseudaphycus maculipennis*	2000
Heliothrips haemorrhoidalis	*Thripobius semiluteus*	2000
Sitona lepidus	*Microctonus aethiopoides*	2005
Uraba lugens	*Cotesia urabae*	2010
Removal of ruminant dung		
Ruminant dung	11 scarabaeid species	2011

Biocontrol Beats Herbicide for Heather Control

Recent work has quantified the impact biocontrol is having on heather (*Calluna vulgaris*) on the Central Plateau, and at high densities the heather beetle (*Lochmaea suturalis*) is effective at killing heather. However, populations have been more difficult than expected to establish, and research to identify factors that might be limiting beetle establishment has been underway for several years. Recent monitoring shows that our efforts have not been in vain as native plants are now starting to benefit from the removal of heather at a number of sites.

Currently, three discrete beetle populations are attacking large areas of heather (> 4 ha) in and around Tongariro National Park following their release in 2001. At the largest outbreak in the Waiouru Military Training Area, 99% of heather in an 80-ha area has been killed so far. "More newly established beetle populations are building at four other sites in and around the park and we expect to see large areas of dead heather at these locations in the next few years too," said Paul Peterson, who has been heavily involved in the project.

A field experiment to quantify heather beetle impact and compare its performance with other control methods was set up in 2007. Four treatments were used: no control (insecticide added to prevent beetle attack), biocontrol only (beetles allowed to attack and nothing added), herbicide control only (insecticide and herbicide added), and combined control (beetles allowed to attack and herbicide added). The experiment showed that left uncontrolled heather is still spreading and becoming denser. Increasing heather cover reduces native species abundance and diversity. The herbicide treatment (Pasture Kleen®) controlled heather well, reducing cover by 90% after two years (two applications). Over the same period heather beetle damage reduced heather cover by 99%, and the combined treatment of herbicide and biocontrol gave the same result (99.9%). However, where the treatments differed was in terms of non-target impact. Treatment by herbicide reduced the cover of native woody shrub species, e.g. sprawling coprosma (*Coprosma cheesemanii*), and some to the point where they could no longer be found, e.g. monoao (*Dracophyllum subulatum*). One advantage of herbicide application was that it also eliminated another invasive weed, mouse-ear hawkweed (*Pilosella officinarum*). In the biocontrol-only plots the woody species that had been adversely affected in the herbicide plots either stayed the same or grew larger. The same pattern applied to herbaceous ground cover species. The most notable change in plots exposed to both beetle and herbicide control was an increase in the introduced grass browntop (*Agrostis capillaris*).

These results clearly show that biocontrol outperforms herbicide for controlling heather because there is no non-target damage. "Native species benefit by reduced competition from heather and are able to recover. There is some evidence of this happening after just two years of biocontrol," said Paul. Herbicide application, by contrast, has significant and lasting non-target impacts, which get more severe after each application and may even eliminate some native species altogether.

Work is continuing to help speed up the spread of beetles throughout the Central Plateau including an experiment to boost foliar nitrogen levels in heather at new release sites to "kick-start" beetle populations. "There are early indications that nitrogen addition may be improving establishment – we have seen outbreaks at a couple of sites two years after they were fertilised," said Paul. However, it is still too early to be certain that raised nitrogen levels are the primary cause.

Feeding behaviour may also be a contributing factor towards poor heather beetle performance, particularly for populations that crash after establishing. Heather beetles appear to do

Right to left: Uncontrolled plot, plot attacked by heather beetle and plot with herbicide treatment. Note the white flowers of the native *Ozothamnus leptophyllus* disappear after herbicide control.

better when feeding in dense groups and their potential to damage heather could also be linked to the density of host plants. "Heather beetle outbreaks typically involve a narrow band where extremely high densities of adults and/or larval feeding occur," said Paul. It has been suggested that if heather density is too patchy then the beetles' ability to engage in mass-feeding will be reduced. Observations of patchy sites on the Central Plateau show that beetles do not cause as severe damage as expected and do not build up to such dense populations. In addition, lab experiments have shown that larval development can be enhanced when feeding on material that has had prior feeding damage. Adult beetles feed heavily on heather while ovipositing and this may precondition the foliage in some way for newly hatched larvae to feed on. If this is so, larvae will not cause as much damage to heather that has not already been nibbled on by adults.

We have plans to supplement the heather beetle population in New Zealand with beetles from more closely climate-matched areas in Europe. Heather beetles overseas are often infected with microsporidian disease, which can be difficult to eliminate. It was a painstaking process to obtain clean beetles to release in New Zealand. However, if we import only male beetles from the UK or Spain, and dispose of them as soon as they have mated with New Zealand females in containment, we can reduce the risks of ending up with an infected colony. Microsporidial disease is also now more easily detected, and testing can be performed on live insects thanks to new molecular techniques we have developed. More precise detection techniques will also enable us to determine whether low levels of microsporidia found in New Zealand heather beetles might be due to them having acquired a different species of microsporidian disease in the field since they have been released.

This project is funded by the Ministry of Science and Innovation (through the Beating Weeds Programme), the New Zealand Army and the Department of Conservation.

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Farewell to Julia and Helen

Julia Wilson-Davey has been a major contributor to this newsletter since 2004 and has taken the lead role in its production in recent years. However, last year Julia moved with her family to Wellington and this month began a new job at Te Papa, so this is the last issue Julia will be helping with. During the decade that Julia was with Landcare Research she got involved in many different projects, including mass rearing and distribution of weed biocontrol agents, educational initiatives to raise awareness about weed issues amongst school children, pollination studies, curation of herbarium specimens, and various glasshouse and field studies to unravel the mysteries of plant ecology. "In my biocontrol work I particularly enjoyed rearing the old man's beard saw flies (*Monophadnus spinolae*). They were very cute and Hugh and I worked with them for a long time – it's a real shame they didn't establish," said Julia. Thanks Julia for your versatility and diligence. Nothing was ever too much trouble and always completed to a high standard. We wish you all the best for the future!

Recently we also farewelled Helen Parish, who was also with us for nearly a decade. Helen was responsible for much of the mass-rearing of weed biocontrol agents at Lincoln. She helped to produce, package up and send off releases of more than a dozen species including more than 50 nucleus populations of ragwort plume moth (*Platyptilia isodactyla*), nearly 100 of green thistle beetle (*Cassida rubiginosa*) and nearly 40 of broom leaf beetle (*Gonioctena olivacea*). Insect rearing can be messy work, requiring at times effort 7 days a week and we also thank Helen for all her hard work. Helen can take some satisfaction in the knowledge that ragwort plume moth has established well and is making inroads into the last remaining stands of ragwort. Also while the broom leaf beetle appears to be a bit of a slow starter, the green thistle beetle is showing much promise causing noticeable damage at some release sites already.

Lara Nicholson is now looking after mass-rearing of weed biocontrol agents at Lincoln with assistance from Susie Scobie.

Julia (green shirt) showing school kids how to use a beating tray to catch broom biocontrol agents.

Autumn Activities

The distinctive pupal case of the tradescantia leaf beetle. (note actual size is 8-10mm long).

There are a few things you might want to fit in before the wind down towards winter:

Boneseed leafroller (*Tortrix* s.l. sp. "chrysanthemoides")

- Check release sites. Look for stem tips where caterpillars have tied the leaves together with webbing to make feeding shelters. The caterpillars are olive-green when small and become darker with rows of white spots as they mature. We would be very interested to hear if you find large numbers and/or significant damage.
- Do not harvest caterpillars until spring.

Broom gall mites (*Aceria genistae*)

- Check release sites for hairy deformities, about 5 to 30 mm across. We would be very interested to hear if you find any or large numbers of galls.
- While it may still be a bit early at some release sites, autumn is a good time to redistribute galls, should you find them in high numbers. Aim to shift at least 15 galls by tying cut shoots onto several plants at the new site – this enables the tiny mites to walk across. We expect the mites to disperse slowly, so redistribution efforts will be important.

Gall-forming agents

- Early autumn is the best time to check release sites for many gall-forming agents. If you find large numbers of galls caused by the **mist flower gall fly** (*Procecidochares alani*) and **hieracium gall wasp** (*Aulacidea subterminalis*) you could harvest mature specimens and release them at new sites. Look out for mist flower galls with windows in them as this shows that the new adults have not already emerged.
- Do not collect galls caused by the **hieracium gall midge** (*Macrolabis pilosellae*), however, as it is best redistributed by moving whole plants in the spring.
- At **nodding** and **Scotch thistle gall fly** (*Urophora solstitialis* and *U. stylata*) release sites look for fluffy or odd-looking flowerheads that feel lumpy and hard when squeezed. Collect infested flowerheads and put them in an onion or wire mesh bag. At the new release site hang the bag on a fence and over winter the galls will rot down and adult flies will emerge in the spring.

Gorse pod moth (*Cydia succedana)*

- Autumn is a good time to check pods for creamy-coloured caterpillars and/or their granular frass, as gorse seed weevil (*Apion ulicis*) is not present to confuse you. You may also see small entry/exit holes in the pod wall.
- This agent is widespread but can be redistributed by moving branches of infested pods if you find areas where it is not present.

Tradescantia leaf beetle (*Neolema ogloblini*)

- Although release sites are still very new it might be worth looking for leaves that have notches in the edges caused by adult feeding or which have been skeletonised by larvae grazing off the green tissue. You may see the dark metallic bronze adults but they tend to drop or fly away when disturbed. It may be easier to spot the larvae, which have a distinctive protective covering over their backs. Young larvae are gregarious and may be seen in packs forming feeding fronts. Older larvae feed individually. The pupal cocoons are extremely unusual (white, star-shaped and resemble styrofoam) and may be visible on damaged foliage (see photo). We would be very interested to hear if you find any sign of the beetles.
- It is likely to be too soon to begin harvesting the beetles.

Woolly nightshade lace bug (*Gargaphia decoris*)

- Check release sites for white chlorotic spots on the leaves and speckles of black frass along the leaf margins. You might see dark egg batches on the pale undersides of the leaves, or the pale brown adults or nymphs that both tend to cluster in groups – we would be very interested to hear if you do.
- It is probably best to leave any harvesting of lace bugs until spring.

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