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LANDCARE RESEARCH
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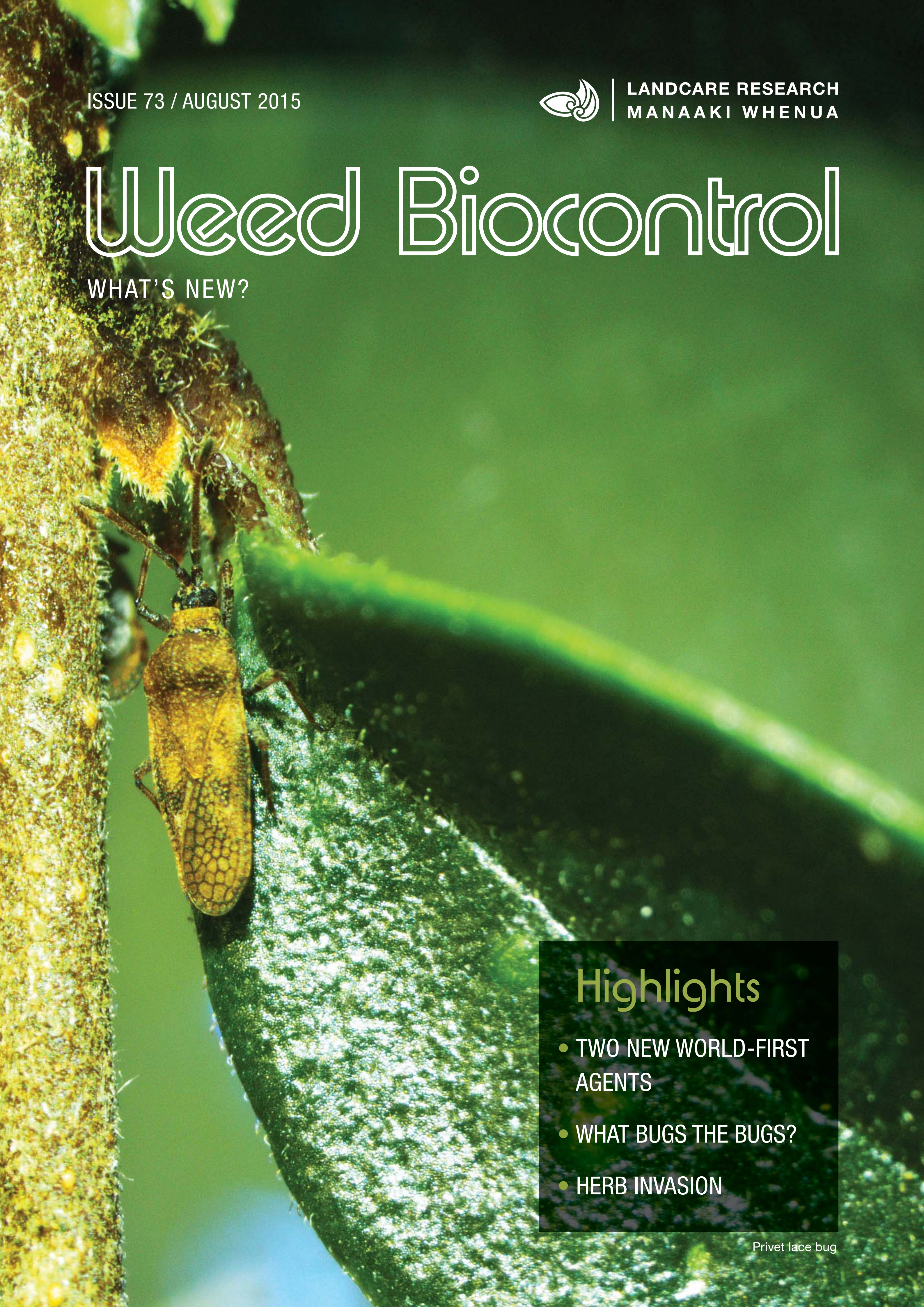
Weed Biocontrol

WHAT'S NEW?



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FROM THE EDITOR

We have refreshed the look of this newsletter to bring it into line with other Landcare Research publications, but the content, style and purpose (to keep you updated and informed about weed biocontrol research) remain unchanged. This is the slightly longer issue that we produce each August. Thanks to our many loyal readers who regularly send feedback after each issue. It is always wonderful to receive this and please keep it coming. If you still receive a hard copy and are ready to make the move to an electronic version, please let me know. Happy reading! Lynley.

New World Biocontrol Catalogue

The last (4th) version of Julien and Griffiths' *A World Catalogue of Agents and their Target Weeds* was published in 1998. For many years this was the go-to place to find out what weed biocontrol agents have been released around the world and how successful they have been, but had become seriously out of date. Recently an international team of researchers, led by Rachel Winston, has undertaken a major revision and expansion of this catalogue, which now includes 224 weeds and 552 agents. This was a huge task to which Landcare Research contributed updated information about weed biocontrol agents in New Zealand. A full online version of the catalogue is available from www.ibiocontrol.org/catalog/ and includes querying capabilities to allow for sorting by key pieces of information, such as by weed or by agent and by bioherbicide. Clicking on individual releases will bring you to the full information available, along with supporting references. It is hoped that a mechanism can be found to allow the catalogue to be kept up to date from now on. A shorter print version (current through 2012) has also been prepared and a pdf of this is available on the website.

Funding for both the print and online versions of the catalogue was provided by the United States Forest Service (Forest Health Technology Enterprise Team). Work was conducted by MIA Consulting, the University of Georgia, the Queensland Department of Agriculture, Fisheries & Forestry, the University of Idaho, and the Centre for Agricultural Bioscience International.

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BIOCONTROL AGENTS RELEASED IN 2014/15

Species	Releases made
Broom gall mite (*Aceria genistae*)	81
Darwin's barberry seed weevil (*Berberidicola exeratus*)	1
Green thistle beetle (*Cassida rubignosa*)	5
Lantana blister rust (*Puccinia lantanae*)	2
Lantana leaf rust (*Prospodium tuberculatum*)	7
Tradescantia leaf beetle (*Neolema ogloblini*)	13
Tradescantia stem beetle (*Lema basicostata*)	5
Tradescantia tip beetle (*Neolema abbreviata*)	2
Woolly nightshade lace bug (*Gargaphia decoris*)	9
Total	125

Herb Invasion in Hawke's Bay

Lesser calamint (*Calamintha nepeta*) is now a target on Landcare Research's weed radar. Overseas, this aromatic plant is grown for its medicinal properties and as a culinary herb. A member of the mint family (Lamiaceae) and native to Europe, North Africa, Western Asia and the Caucasus, lesser calamint has become naturalised in the United States and New Zealand. It was first recorded here in the early 1900s and is known to be present in Gisborne, Whanganui, Levin and Nelson, but is primarily a problem so far only in Hawke's Bay, where there are serious infestations on over 100 farms.

Lesser calamint produces fine, upright stems that are covered with small, shiny, green oregano-like leaves, forming a compact mound 30 to 50 cm tall and twice as wide. In late summer, a cloud of minute pale lavender flowers are produced that bloom for up to 6 weeks and produce many seeds. As the days become cooler, the colour of the blossoms deepens. The plant can become dormant in the winter months, and then blossom again in spring. Lesser calamint smells like a cross between mint and oregano and attracts honeybees and butterflies.

Darin Underhill from the Hawke's Bay Regional Council reports that lesser calamint is difficult to control with herbicides and is not palatable to stock so it can quickly outcompete pasture plants. "I have been observing this plant spreading for the past 7 or 8 years but because it is small, doesn't have prickles and isn't poisonous, it hasn't come to the attention of many people," Darin added. However, the plant is already having an economic impact on badly infested properties.

The Hawke's Bay Regional Council recently asked Landcare Research to explore the feasibility of biocontrol for this plant. "Biocontrol is probably the only remaining option for this plant," said Ronny Groenteman, who led the study. "Lesser calamint has the potential to become a much more serious weed in New Zealand because of its tolerance range," explained Ronny. In its native range lesser calamint is valued for its ability to grow in dry, disturbed, low-fertility soils with low organic matter. It prefers well-drained, dry to moist, neutral to alkaline soil, and a warm sunny site, but can withstand temperatures down to -15°C, as well as drought, and full sun to part-shade.

The feasibility study predicts that, in terms of likelihood of biocontrol success, lesser calamint would be an intermediate target. The lack of close relatives to lesser calamint in the New Zealand flora increases the likelihood of finding agents that are sufficiently host specific. New Zealand has five indigenous plant species in the Lamiaceae family, one (which is endemic) is considered threatened, two (one endemic and one non-endemic)

Darin Underhill

Lesser calamint growing wild and unwanted in Hawke's Bay

are declining, and the other two (both non-endemic) species are not threatened. A biocontrol programme would also have to make sure that widely used culinary herbs in the mint family are not harmed by potential agents; however, these are sufficiently distantly related to lesser calamint that it would be expected that agents could be found that would not harm them.

No detailed surveys of the natural enemies of lesser calamint have been undertaken, and would be needed if a biocontrol project was to proceed. Six species of arthropods and three species of pathogens have been recorded from lesser calamint. Information about the host specificity and damage caused by these natural enemies is lacking, but most of them appear to warrant further study.

The feasibility study recommended that the next step should be to conduct a cost-benefit analysis to see if investment in a biocontrol programme would be warranted for a weed of such limited current distribution, but which potentially has much more serious impacts. This would consider future weed spread scenarios and the economic impact on the small number of businesses growing the plant for its medicinal properties. No other countries have attempted biocontrol of this plant and so a project would have to start from scratch, which adds significantly to the development costs, likely to be around the $2M mark.

Ronny was pleased to be involved with such a proactive project. "For years we have advocated the benefits of controlling plants that are in the early stages of invasion (sleeper weeds) rather than leaving them until they become widespread." Darin agrees and said that he wouldn't be surprised if other regions with similar climate and terrain to Hawke's Bay are also quietly being invaded by lesser calamint but just haven't noticed it yet.

This project was funded by an Envirolink grant to the Hawke's Bay Regional Council (1538-HBRC205).

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Two New 'World-First' Agents Ready for Combat

Two new biocontrol agents have recently been approved for release: the privet lace bug (*Leptoypha hospita*) and the Japanese honeysuckle stem beetle (*Oberea shirahatai*). The Environmental Protection Authority (EPA) granted approval to release the privet lace bug in May, with Waikato Regional Council as the applicant on behalf of the National Biocontrol Collective. This is the first agent to be used against Chinese privet (*Ligustrum sinense*) both in New Zealand and worldwide.

Only two of the four privet species naturalised in New Zealand, Chinese privet and the less widespread but larger tree privet (*Ligustrum lucidum*), are considered serious problems at present, particularly in the North Island. Tree privet can grow above the canopy of many native trees and the smaller Chinese privet prevents native seedling regeneration, making both species environmental pests. Privet is also a problem in places that are not intensively managed such as along roadsides and railway lines or in hedgerows. Tolerant of a range of growing conditions, privet grows equally well in dry stony ground and the heavier soils found around the Waikato. The leaves and dark purple berries are poisonous to humans and other animals. Many people, especially in urban areas, believe that privet is responsible for allergic reactions, but the evidence for this is a bit controversial. Possibly the perfume rather than the pollen is an irritant for these people. The berries are attractive to birds, which are great at spreading the seed around to new places.

Privet lace bug

Although manual control can be effective (but expensive) and herbicide application is an option in some areas, biological control is the only reasonable way forward for improving widespread control of these species.

The privet lace bug was identified as a good prospective biocontrol agent by scientists in the USA, who started working on a privet biocontrol project ahead of New Zealand. The lace bug adults and nymphs pierce and suck the sap from the privet leaves damaging the leaf tips, leading to defoliation and reducing the vigour of the plant. "In its native range the lace bug reportedly attacks a range of privet species in addition to Chinese privet and host-range testing has indicated that other *Ligustrum* species present in New Zealand are potential hosts, so it will be interesting to see which additional privet species it can survive on in field conditions in New Zealand," said Quentin Paynter, who has led the New Zealand work.

"We have been fortunate to be able to 'ride on the coat-tails' of the Americans with this project as they had already done quite extensive host testing on plants in the Oleaceae family, which includes olives, when we got interested in the project. The only native plant that needed testing here was *Nestegis*, the only New Zealand plant in the Oleaceae family, and fortunately this was not attacked by the lace bug. "We also tested the ornamental lilac (*Syringa* spp.) varieties that are grown in New Zealand, but the survival of the lace bug on these was very poor so it is expected that there will be only limited spillover non-target attack, if any at all, on lilac if there is privet nearby," said Chris Winks, who has been working alongside Quentin, looking after the lace bugs in the Auckland containment facility.

"The early indications are that the lace bug is relatively easy to rear, which is definitely a bonus," said Quentin. "Mass rearing is underway with the first field releases scheduled to get underway this spring," he added. It is not certain how many generations would occur in the field in New Zealand, but in the field in China

Japanese honeysuckle stem beetle

the lace bug is present as both immature and adult stages for 7 months of the year from early spring. Given the observations in its native range, at least two generations are likely in New Zealand.

Meanwhile, the Japanese honeysuckle stem beetle gained EPA approval for release in July, with the Hawke's Bay Regional Council as applicant on behalf of the National Biocontrol Collective. This use of this agent is also a world first, and it is hoped that the beetle will complement the recently released Honshu white admiral butterfly (*Limenitis glorifica*), which attacks the leaves of the plant. The butterfly was released last season at two sites and we hope this spring to be able to find evidence of establishment and possibly begin to redistribute it.

Adult stem beetles lay eggs by boring a hole into the stem and sliding an egg down the stem, just underneath the bark below the hole. From here a larva emerges, feeds initially on the cambium bark material then crawls up to the hole and burrows into the pith at the centre of the stem, to feed and mature. Leaf and shoot growth above the larval feeding site becomes stunted and often dies as the larva feeds. Larger, older stems 5–15mm in diameter are preferred by adults laying eggs and for larval feeding. The beetle larvae take up to 2 years to develop through to adult stage and during this time they can do a lot of damage, killing entire stems.

Adult beetles were recently collected in Japan, and brought back to our Lincoln containment facility by Hugh Gourlay in June, with the aim of trying to start a colony here in New Zealand. Stem borers are notoriously difficult to rear because the larvae are quite particular about the size and texture of the stems that are available, as well as taking so long to develop. Efforts to rear the stem beetle to date inside containment have found the Japanese honeysuckle beetle to be no exception. "We have to keep the honeysuckle in a healthy condition for 2 years in pots and this is not always easy, especially when they have been damaged by the beetles," explained Hugh.

"We are anticipating that mass-rearing may prove to be too difficult and that it might be best to repeat what we did with the Honshu white admiral: establish the beetle at one or two safe field sites from which we can later harvest for redistribution," said Quentin. One advantage of this species over the white admiral is that it will at least breed in captivity, so there will be the potential to maintain a small 'back-up' colony. "The beetles I brought back from Japan have laid eggs and we now have some larvae developing on Japanese honeysuckle plants growing in our containment facility," said Hugh. "Because they are quite tricky to collect in large numbers in the field in Japan, we will only have a relatively small number to work with once the usual 30 are sacrificed for disease testing," he added. At the last count, Hugh had around 100 larvae to form the basis of a population. Once the beetles have been confirmed to be free of disease, Hugh will apply for permission to remove them from containment. We will likely need to collect more beetles from Japan next year to boost numbers and augment the genetic diversity of our population.

"We won't really know when field releases can begin until we know how well our attempt to "rephase" them to Southern Hemisphere conditions goes and see how many adults we can rear through," cautioned Quentin. Because the larvae take so long to develop and it is difficult to keep potted plants alive in glasshouses, we are hoping to cage potted plants in the field to allow more natural development of the larvae and plants. The cages will ensure that emerging adults can find each other and mate, and be collected up more easily for release at new field sites.

Hugh is also experimenting with rearing the larvae on an artificial diet. Overseas studies on similar beetles reared on artificial diet suggest they develop faster and can take only 1 year to develop to an adult. It may take some time to develop a successful artificial diet approach, but if Hugh can crack this it may eventually allow us to rear larger numbers of beetles indoors in addition to harvesting from field sites.

Both projects were funded by the National Biocontrol Collective. Japanese honeysuckle stem beetle rearing has also been supported by Landcare Research's Capability Funding.

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What's Bugging Our Bugs?

One possible reason for weed biocontrol agents underperforming post release is the presence of unwanted microorganisms that infect the gut and other organs. In New Zealand it has been standard practice since 1984 to routinely screen all biocontrol agents for pathogens before release, but until recently there has been no follow-up research into how effective this screening has been. Over the past two summers Auste Cerniauskaite and Darwin Hickman, students from Birmingham University in the UK, have, as part of their studies, travelled around New Zealand exploring the health status of weed biocontrol agents, in particular comparing those released before and after 1984.

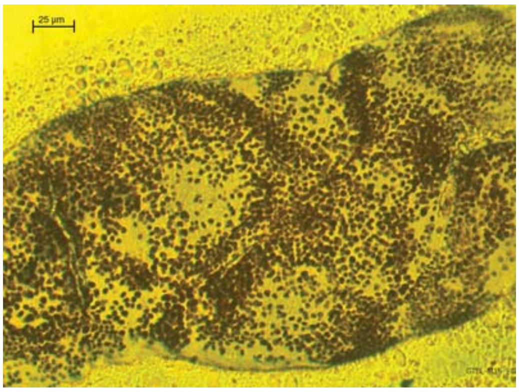
"International awareness surrounding insects hosting microorganisms has developed considerably in recent years and there are now much better DNA techniques available to aid in detecting and identifying them," said Lindsay Smith who supervised the students during their time in New Zealand. "We are continually working to improve our screening procedures, but until now haven't really understood how much of a role unwanted and undetected microorganisms play in the failure of released agents to control their target weeds," he added.

First, Auste undertook a broad survey of 16 biocontrol agents (15 insect and 1 mite species) on eight weeds. These were collected from 27 sites nationwide between October 2013 and March 2014. Four of these agents had been released prior to 1984, when disease screening began: the gorse seed weevil (*Exapion ulicis*) released in 1931; St. John's wort beetles (*Chrysolina hyperici* and *C. quadrigemina* – not separated to species in this study) released in 1943 and 1963, respectively; nodding thistle receptacle weevil (*Rhinocyllus conicus*) released in 1972; and ragwort flea beetle (*Longitarsus jacobaeae*) released in 1983.

On returning to the lab at Lincoln, Auste smeared the insects onto glass slides, stained them to highlight associated microorganisms, and examined the smears using high-power light microscopy. Insect pathogen specialist and microbiologist Sean Marshall from AgResearch was called in to view and comment on selected specimens of interest. Samples containing a high loading of microorganisms were assessed using PCR molecular techniques that targeted a variety of potentially pathogenic microorganisms including fungi, bacteria and Archaea (single-celled microorganisms closely related to eukaryotes).

Auste found that 15 out of the 16 biocontrol agents were free from potentially pathogenic microorganisms. The only exception was the nodding thistle receptacle weevil (*R. conicus*), which had some samples that were 'hooching' with bacteria that could be pathogens. These bacteria could be affecting weevil fecundity, larval size, or longevity and therefore their capacity to consume seeds. The bacteria, which have not yet been identified, were present in weevil specimens collected from one North Island site and three South Island sites, but were absent at other sites.

A decision was then made to focus more fully on thistle agents when Darwin 'picked up the reins' a year later. He sampled 26 sites between December 2014 and March 2015 for seven insect species: the nodding thistle receptacle weevil, crown weevil (*Trichosirocalus horridus*) and gall fly (*Urophora solstitialis*); Californian thistle leaf beetle (*Lema cyanella*) and gall fly (*U. cardui*); Scotch thistle gall fly (*U. stylata*); and the green thistle beetle (*Cassida rubiginosa*). All except the receptacle weevil were screened for potentially pathogenic microorganisms prior to release in New Zealand. Some limited releases of the Californian thistle leaf beetle and gall fly were made prior to 1984 but did not result in establishment. Subsequent efforts to establish both species were made in the 1990s using screened populations, but still with limited success. Despite thousands of leaf beetles being released, they only established at one site near Auckland. The gall fly also remains extremely rare as stock will happily eat galled thistles, and Darwin was unable to collect any usable samples.



Darwin Hickman

Possible symbiotic microorganism within smeared tissue of a green thistle beetle larva (400x magnification)

Darwin used the same techniques as Auste in the laboratory. In total, he found seven distinct potentially pathogenic microorganisms using PCR, six of which were bacteria and the remaining one, which was found in the green thistle beetle, was thought initially to be a *Cryptococcus* yeast. "We are currently working with colleague Mike Cripps from AgResearch and Hassan Salem of the Max Planck Institute in Germany to investigate this further," said Simon Fowler, who leads the Beating Weeds research programme. "Independently, research at the

Max Planck has revealed that the green thistle beetle from Europe and USA has a common, previously undescribed bacterium as a probable gut symbiont. It is uncertain at present whether we have found the same symbiont, or something completely different," he added. Another complication is that even if we find something in our biocontrol agents, we can't be sure whether it was imported with the agent or is something the insects have picked up from the New Zealand environment.

Overall results so far suggest no significant difference in the presence of potentially pathogenic microorganisms in insects released before or after disease screening began, suggesting that the unscreened insects were fortunately clean when released. It may be significant that the one agent found infected with high levels of a potential pathogen, the receptacle weevil, was released without pathogen screening, however more unscreened agent species need to be tested. Although the microorganism in the receptacle weevil may be reducing its performance, it is clear that underperformance on other species is not a result of pathogens suggesting that other factors, such as environmental or abiotic conditions, are possibly more important. For example, the Californian thistle leaf beetle that has only established at one site had no detectable pathogens associated with it.

"Over the past decade, we have encountered a number of pathogens in biocontrol agents that had to be eliminated in containment, as they were quite damaging to their hosts," said Simon. "We have had microsporidia (a single-celled intercellular parasite) in heather beetles and barberry weevils, gregarines (a common protozoan parasite) in the tradescantia beetles, as well as "*Ca*. Liberibacter" in broom psyllids. Ensuring that the insects we released were free from these potential pathogens has meant costly delays to several of our programmes as we have had to work out how to do this," said Simon. "Fortunately not all of the microorganisms we detect, e.g. with PCR, appear to be harmful to the insects, and some might even be symbiotic with a mutually beneficial relationship," he added. Sorting out whether detected microorganisms are potential pathogens (which may cause agent underperformance), or beneficial symbionts (without which the agent may also underperform), is going to be a future research challenge.

"Auste and Darwin have both returned to the UK to complete their studies but their reports provide a valuable contribution to our work and a good foundation for further research," said Lindsay. One of the long-term aims of this research is to improve screening methods for microorganisms that may be pathogenic, so they can be eliminated more cost-effectively. For example, if the frass (faeces) of individual insects collected from the field in the native range can be tested for potentially pathogenic microorganisms, unclean insects can be rejected at an early stage. "If the presence of pathogens is eliminated from the equation, and is not influencing the effectiveness of the insects, it takes out one of the potentially big performance variables," Lindsay concluded.

This project is funded by the Ministry of Business, Innovation and Employment as part of Landcare Research's Beating Weeds programme. We are grateful to the many regional council staff who assisted by providing specimens, access to field sites or useful advice.

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Darwin collecting thistle samples

Spring Activities

Most biocontrol agents become active during spring, making it a busy time of year to check release sites and move agents around.

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

- Check release sites for feeding shelters made by caterpillars webbing together leaves at the tips of stems. Also look for "windows" in the leaves and sprinkles of black frass. Small caterpillars are olive green in colour and become darker, with two parallel rows of white spots as they mature.
- Caterpillars can be harvested if you find them in good numbers. Cut off infested boneseed tips and wedge them into plants at new sites. Aim to shift at least 500 caterpillars to sites where scale insects and invasive ants are not known to be present.

Broom gall mites (*Aceria genistae*)

- Check release sites for galls, which look like deformed lumps and range in size from 5 to 30 mm across. Heavily galled plants may be dead or dying.
- If galls are present in good numbers, late spring – early summer is the best time to undertake harvesting and redistribution. Because the mites are showing much promise but are expected to disperse quite slowly, it will be important for all regions with a major broom problem to plan a comprehensive redistribution programme. Aim to shift at least 50 galls to each site and tie them onto plants so the tiny mites can shift across.

Broom leaf beetles (*Gonioctena olivacea*)

- Check release sites by beating plants over a tray. Look for the adults, which are 2–5 mm long and goldish-brown (females) through to orangey-red (males) with stripes on their backs. Look also for greyish-brown larvae that may also be seen feeding on leaves and shoot tips.
- It is probably still a bit soon to begin harvesting and redistribution.

Broom shoot moth (*Agonopterix assimilella*)

- Late spring is the best time to check release sites. Look for the caterpillars' feeding shelters made by webbing twigs together. Small caterpillars are dark reddish-brown and turn dark green as they get older. We have found reasonable evidence of establishment only at one site in Southland to date, so we will be interested to hear if you find any sign of the caterpillars.
- We would not expect you to be able to begin harvesting and redistribution just yet.

Lantana leaf rust

Green thistle beetles (*Cassida rubiginosa*)

- Check release sites for adult beetles, which emerge on warm days towards the end of winter and feed on new thistle leaves, making round window holes. The adults are 6–7.5 mm long and green, but are quite well camouflaged against the leaf. The larvae also make windows in the leaves. They have a protective covering of old moulted skins and excrement. You may also see brownish clusters of eggs on the underside of leaves.
- It should be possible to harvest beetles at many of the older sites. Use a garden-leaf vacuum machine and aim to shift at least 50 adults from spring throughout summer and into autumn. Be careful to separate the beetles from other material collected, which may include pasture pests.

Lantana blister rust (*Puccinia lantanae*)

- Check sites where lantana plants infected with blister rust were planted out last autumn, especially after a period of warm, wet weather. Signs of infection include leaf and stem chlorosis (yellowing) accompanied by large, dark pustules on the undersides of leaves and on the stems. Once infection is well-established, stunting, defoliation and die-back may also occur.
- Once established this rust is likely to be readily dispersed by the wind. If redistribution efforts are needed the best method will likely involve placing small potted lantana plants beneath infected ones and then planting these out at new sites once they have become infected. However, to propagate and distribute lantana in this manner an exemption from the Ministry for Primary Industries will be required.

Lantana leaf rust (*Prospodium tuberculatum*)

- Check sites where the leaf rust was released last autumn, especially after a period of warm, wet weather. Look for yellowing on the leaves with corresponding brown pustules and spores, rather like small coffee granules. A hand lens may be needed to see the symptoms during early stages of infection.
- Once established this rust is likely to be readily dispersed by the wind. If redistribution efforts are needed the best method will likely involve harvesting infected leaves and brushing the spores onto young leaves.

Ragwort plume moth (*Platyptilia isodactyla*)

- October is the best time to check release sites for caterpillars. Look for plants with wilted or blackened or blemished shoots with holes and an accumulation of debris, frass or silken webbing. Pull back the leaves at the crown of damaged plants to look for large, hairy, green larvae and pupae. Also check where the leaves join bolting stems for holes and frass. Don't get confused by larvae of the blue stem borer (*Patagoniodes farinaria*), which look similar to plume moth larvae until they develop their distinctive bluish colouration.
- If the moth is present in good numbers, the best time to shift it around is in late spring. Dig up damaged plants, roots and all. Pupae may be in the surrounding soil so retain as much as possible. Shift at least 50–100 plants, but the more the better. Place one or two infested plants beside a healthy ragwort plant so any caterpillars can crawl across.

Tradescantia leaf beetle (*Neolema ogloblini*)

- Check release sites, especially the older ones. Look for notches in the edges of leaves caused by adult feeding or leaves that have been skeletonised by larvae grazing off the green tissue. You may see the dark metallic bronze adults sitting on the foliage or the larvae, which have a distinctive protective covering over their backs. The white, star-shaped pupal cocoons may also be visible on damaged foliage.
- Redistribution has begun at some of the older sites. If you can see plenty of beetles sitting about then harvesting can begin. Aim to collect and shift 50–100 beetles. Collect the beetles either using a suction device or a small net.

Tradescantia stem beetle (*Lema basicostata*)

- Check release sites, especially the older ones. The black knobbly adults tend to drop when disturbed, and can be difficult to see. Look for their feeding damage, which consists of elongated windows in the upper surfaces of leaves or sometimes whole leaves consumed. The larvae inside the stems will also be difficult to spot. Look for stems showing signs of necrosis or collapse and brown frass.
- If you can find widespread damage at the site then you may be able to begin harvesting and redistribution. We still need to identify the best possible method to do this. If it proves to be too difficult to collect 50–100 adults with a suction device, then another approach to try would be to remove a quantity of the damaged material and put it in a wool pack or on a tarpaulin and wedge this into tradescantia at new sites. However, to distribute tradescantia in this manner an exemption from the Ministry for Primary Industries will be required.

Tradescantia tip beetle (*Neolema abbreviata*)

- Check release sites, especially the older ones. The adults are mostly black with yellow wing cases, and you may see them sitting about on the foliage. Look also for their feeding damage, which looks like elongated windows in the leaves, similar to the stem beetle. Larvae will also be difficult to see when they are feeding inside the tips, but brown frass may be visible. When tips are in short supply, the slug-like larvae feed externally on the leaves.
- We expect it is probably still a bit soon to begin harvesting and redistribution just yet.

Other agents

You might also need to check or distribute the following this spring:

- Gorse soft shoot moth (*Agonopterix umbellana*)
- Gorse thrips (*Sericothrips staphylinus*)
- Gorse colonial hard shoot moth (*Pempelia genistella*

National Assessment Protocol

For those taking part in the National Assessment Protocol, spring is the appropriate time to check for establishment and/or assess population damage levels for the species listed in the table below. You can find out more information about the protocol and instructions for each agent at: www.landcareresearch.co.nz/publications/books/biocontrol-of-weeds-book

Target	When	Agents
Broom	Oct-Nov	Leaf beetle (*Gonioctena olivacea*)
	Oct-Nov	Psyllid (*Arytainilla spartiophila*)
	Sept-Oct	Shoot moth (*Agonopterix assimilella*)
	Aug-Sept	Twig miner *Leucoptera spartifoliella*)
Lantana	Oct-Nov (or March-May)	Blister rust (*Puccinia lantanae*) Leaf rust (*Prospodium tuberculatum*)
Tradescantia	Nov-April	Leaf beetle (*Neolema ogloblini*) Stem beetle (*Lema basicostata*) Tip beetle (*Neolema abbreviata*)

Send any reports of interesting, new or unusual sightings to Lynley Hayes: hayesl@landcareresearch.co.nz, ph 03 321 9694.

Who's Who in Biological Control of Weeds?

Alligator weed beetle (*Agasicles hygrophila*) Alligator weed beetle (*Disonycha argentinensis*) Alligator weed moth (*Arcola malloi*)	Foliage feeder, common, often provides excellent control on static water bodies. Foliage feeder, released widely in the early 1980s, failed to establish. Stem borer, 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, established and quite common at some NI sites but no significant damage yet. Appears to be limited by predation and parasitism.
Bridal creeper rust (*Puccinia myrsiphylli*)	Rust fungus, self-introduced, first noticed in 2005, widespread, causing severe damage at many sites.
Broom gall mite (*Aceria genistae*) Broom leaf beetle (*Gonioctena olivacea*) Broom psyllid (*Arytainilla spartiophila*) Broom seed beetle (*Bruchidius villosus*) Broom shoot moth (*Agonopterix assimilella*) Broom twig miner (*Leucoptera spartifoliella*)	Gall former, recently released widely, establishing well and already severely damaging plants at some sites. Foliage feeder, recently released widely, establishment appears likely at a few sites so far. Sap sucker, becoming common, some damaging outbreaks seen, but may be limited by predation, impact unknown. Seed feeder, common in many areas, now destroying up to 84% of seeds at older release sites. Foliage feeder, recently released at limited sites as difficult to rear, establishment appears likely at one site to date. Stem miner, self-introduced, common, often causes obvious damage.
Californian thistle flea beetle (*Altica carduorum*) Californian thistle gall fly (*Urophora cardui*) Californian thistle leaf beetle (*Lema cyanella*) Californian thistle rust (*Puccinia punctiformis*) Californian thistle stem miner (*Ceratapion onopordi*) Green thistle beetle (*Cassida rubiginosa*)	Foliage feeder, released widely during the early 1990s, failed to establish. Gall former, extremely rare as galls tend to be eaten by sheep, impact unknown. Foliage feeder, only established at one site near Auckland where it causes obvious damage. Systemic rust fungus, self-introduced, common, damage usually not widespread. Stem miner, attacks a range of thistles, recently released at limited sites as difficult to rear, establishment success unknown. Foliage feeder, attacks a range of thistles, recently released widely, establishing well and some damaging outbreaks beginning to occur.
Chilean needle grass rust (*Uromyces pencanus*)	Rust fungus, approved for release in 2011 but no releases made yet as waiting for export permit to be granted, only SI populations likely to be susceptible.
Darwin's barberry flower bud weevil (*Anthonomus kuscheli*) Darwin's barberry seed weevil (*Berberidicola exaratus*)	Flower bud feeder, approved for release in 2012, releases are likely to be made after the seed weevil is established if still needed. Seed feeder, approved for release in 2012, first release made in early 2015 and more planned for 2015/16.
Gorse colonial hard shoot moth (*Pempelia genistella*) Gorse hard shoot moth (*Scythris grandipennis*) Gorse pod moth (*Cydia succedana*) Gorse seed weevil (*Exapion ulicis*) Gorse soft shoot moth (*Agonopterix umbellana*) Gorse spider mite (*Tetranychus lintearius*) Gorse stem miner (*Anisoplaca pytoptera*) Gorse thrips (*Sericothrips staphylinus*)	Foliage feeder, from limited releases established only in Canterbury, impact unknown, but obvious damage seen at several sites. Foliage feeder, failed to establish from small number released at one site, no further releases planned due to rearing difficulties. Seed feeder, common in many areas, can destroy many seeds in spring but not as effective in autumn, not well synchronised with gorse-flowering in some areas. Seed feeder, common, destroys many seeds in spring. Foliage feeder, established poorly in the NI but well established and common in parts of the SI, some impressive outbreaks seen, impact unknown. Sap sucker, common, often causes obvious damage, but ability to persist is limited by predation. Stem miner, native, common in the SI, often causes obvious damage, lemon tree borer has similar impact in the NI. Sap sucker, common in many areas, impact unknown.
Heather beetle (*Lochmaea suturalis*)	Foliage feeder, established in and around Tongariro National Park also Rotorua, 1300 ha heather damaged/killed at TNP since 1996. New strains more suited to high altitude have recently been released.
Hemlock moth (*Agonopterix alstromeriana*)	Foliage feeder, self-introduced, common, often causes severe damage.

Hieracium crown hover fly (*Cheilosia psilophthalma*) Hieracium gall midge (*Macrolabis pilosellae*) Hieracium gall wasp (*Aulacidea subterminalis*) Hieracium plume moth (*Oxyptilus pilosellae*) Hieracium root hover fly (*Cheilosia urbana*) Hieracium rust (*Puccinia hieracii* var. *piloselloidarum*)	Crown feeder, released at limited sites as difficult to rear, establishment success unknown. Gall former, established in both islands, common near Waiouru where it has reduced host by 18% over 6 years, also very damaging in laboratory trials. Gall former, established but not yet common in the SI and has not established yet in the NI, impact unknown but reduces stolon length in laboratory trials. Foliage feeder, only released at one site due to rearing difficulties, did not establish. Root feeder, released at limited sites as difficult to rear, establishment success unknown. Leaf rust fungus, self-introduced?, common, causes slight damage to some mouse-ear hawkweed, plants vary in susceptibility.
Japanese honeysuckle white admiral (*Limenitis glorifica*) Japanese honeysuckle stem beetle (*Oberea shirahati*)	Foliage feeder, approved for release in 2013, cannot be reared in captivity, released at 2 field sites in 2014 and hope to harvest from these if establishment confirmed. Stem miner, approved for release in 2015, difficult to rear in captivity, hope to make first field release before end of 2015.
Lantana blister rust (*Puccinia lantanae*) Lantana leaf rust (*Prospodium tuberculatum*) Lantana plume moth (*Lantanophaga pusillidactyla*)	Leaf and stem rust fungus, approved for release in 2012, releases began autumn 2015, establishment success unknown. Leaf rust fungus, approved for release in 2012, releases began autumn 2015, establishment success unknown. Flower feeder, self-introduced, host range, distribution and impact unknown.
Mexican devil weed gall fly (*Procecidochares utilis*) Mexican devil weed leaf fungus (*Passalora ageratinae*)	Gall former, common, initially high impact but now reduced considerably by Australian parasitic wasp. Leaf fungus, introduced with gall fly in 1958, common and almost certainly having an impact.
Mist flower fungus (*Entyloma ageratinae*) Mist flower gall fly (*Procecidochares alani*)	Leaf smut, common and often causes severe damage. Gall former, common now at many sites, in conjunction with the leaf smut provides excellent control of mist flower.
Moth plant beetle (*Colaspis argentinensis*)	Root feeder, approved for release in 2011 but no releases made yet as waiting for export permit to be granted by Argentinean authorities.
Nodding thistle crown weevil (*Trichosirocalus horridus)* Nodding thistle gall fly (*Urophora solstitialis*) Nodding thistle receptacle weevil (*Rhinocyllus conicus*)	Root and crown feeder, becoming common on several thistles, often provides excellent control in conjunction with other thistle agents. Seed feeder, becoming common, can help to provide control in conjunction with other thistle agents. Seed feeder, common on several thistles, can help to provide control of nodding thistle in conjunction with other thistle agents.
Old man's beard leaf fungus (*Phoma clematidina*) Old man's beard leaf miner (*Phytomyza vitalbae*) Old man's beard sawfly (*Monophadnus spinolae*)	Leaf fungus, initially caused noticeable damage but has become rare or died out. Leaf miner, common, damaging outbreaks occasionally seen, but appears to be limited by parasitism. Foliage feeder, released at limited sites as difficult to rear, probably failed to establish.
Cinnabar moth (*Tyria jacobaeae*) Ragwort crown-boring moth (*Cochylis atricapitana*) Ragwort flea beetle (*Longitarsus jacobaeae*) Ragwort plume moth (*Platyptilia isodactyla*) Ragwort seed fly (*Botanophila jacobaeae*)	Foliage feeder, common in some areas, often causes obvious damage. Stem miner and crown borer, released widely, has probably failed to establish. Root and crown feeder, common, provides excellent control in many areas. Stem, crown and root borer, recently released widely, well established and quickly reducing ragwort noticeably at many sites. Seed feeder, established in the central NI, no significant impact.
Greater St John's wort beetle (*Chrysolina quadrigemina*) Lesser St John's wort beetle (*Chrysolina hyperici*) St John's wort gall midge (*Zeuxidiplosis giardi*)	Foliage feeder, provides excellent control in conjunction with the lesser St John's wort beetle. Foliage feeder, common, provides excellent control in conjunction with the greater St John's wort beetle. Gall former, established in the northern SI, often causes severe stunting.
Scotch thistle gall fly (*Urophora stylata*)	Seed feeder, released at limited sites, establishing and spreading readily, fewer thistles observed at some sites, impact unknown.
Tradescantia leaf beetle (*Neolema ogloblini*) Tradescantia stem beetle (*Lema basicostata*) Tradescantia tip beetle (*Neolema abbreviata*) Tradescantia yellow leaf spot (*Kordyana* sp.)	Foliage feeder, released widely since 2011, establishing well and beginning to cause noticeable damage. Stem borer, releases began in 2012, establishing well with major damage seen at one site already. Tip feeder, releases began in 2013 and are continuing, appears to be establishing readily. Leaf fungus, approved for released in 2013, releases are on hold until the impact of the beetles is known and the need for the fungus confirmed.
Woolly nightshade lace bug (*Gargaphia decoris*)	Sap sucker, recently released widely, establishing readily at many sites, some damaging outbreaks are beginning to occur.

Further Reading

Bellgard S, Probst C, Winks C, Fowler S 2015. **Feasibility study for the biological control of giant buttercup *Ranunculus acris* L.** Landcare Research Contract Report LC2066 prepared for AgResearch. 21p.

Bellgard S, Winks C, Probst C, Anand N, Fowler S, Smith L, Peterson P 2015. **Invertebrates, fungal pathogens and endophytes associated with giant buttercup, *Ranunculus acris* (Ranunculaceae), in New Zealand.** Landcare Research Contract Report LC2039 prepared for AgResearch. 31p.

Fowler S, Peterson P, Barrett P, Forgie S, Gleeson D, Harman H, Houliston G, Smith L 2015. **Investigating the poor performance of heather beetle, *Lochmaea suturalis* (Thompson) (Coleoptera: Chrysomelidae), as a weed biocontrol agent in New Zealand: has genetic bottlenecking resulted in small body size and poor winter survival?** Biological Control 87: 32–38.

Houliston G, Goeke D, Smith L, Fowler S 2015. **The genetic variation in giant buttercup in New Zealand pastures.** New Zealand Plant Protection 68: 112–117.

Groenteman R, Bellgard S, Houliston G 2015. **Feasibility of biological control for lesser calamint, *Calaminth nepeta*.** Landcare Research Contract Report LC2223 prepared from the Hawke's Bay Regional Council (Envirolink Advice Grant: 1538-HBRC205). 23p.

Paynter Q 2014. **Biological control of economically and environmentally important weeds in the Cook Islands: New Zealand Partnerships for International Development Fund Project PF 1-314**. Quarterly Progress Report: July 2014. Landcare Research Contract Report LC1953 prepared for the Ministry of Foreign Affairs and Trade. 14p.

Paynter Q 2015. **Biological control of economically and environmentally important weeds in the Cook Islands: New Zealand Partnerships for International Development Fund Project PF 1-314.** Annual report prepared for the Ministry of Foreign Affairs and Trade. 16p.

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Paynter Q, Fowler S, Hayes L, Hill R 2015. **Factors affecting the cost of weed biocontrol programs in New Zealand.** Biological Control 80: 119–127.

Paynter Q, Fowler S, Gourlay H, Peterson P, Smith L, Winks C 2015. **Relative performance on test and target plants in laboratory tests predicts the risk of non-target attack in the field for arthropod weed biocontrol agents.** Biological Control 80: 133–142.

Peterson P, Fowler S, Barrett D, Smith L, Merrett M, Forgie S, Gleeson D, Houliston G, Hayman E 2015. **Biological control of heather (*Calluna vulgaris*): Re-introduction of the heather beetle (*Lochmaea suturalis*) into New Zealand.** Landcare Research Contract Report LC2228 prepared for the NZ Defence Force and the Department of Conservation. 57p.

Winks C, Bellgard S, Smith L, Anand N, Probst C, Peterson P, Hoyer A 2014. **Invertebrates and fungi associated with field horsetail, *Equisetum arvense* (Equisetaceae), in New Zealand.** Landcare Research Contract Report LC2012 prepared for NZ Landcare Trust (on behalf of the Lower Rangitikei Horsetail Control Group). 27p.

Previous issues of this newsletter are available from:
http://www.landcareresearch.co.nz/publications/newsletters/biological-control-of-weeds