WHAT'S NEW IN

Biological Control of Weeds?

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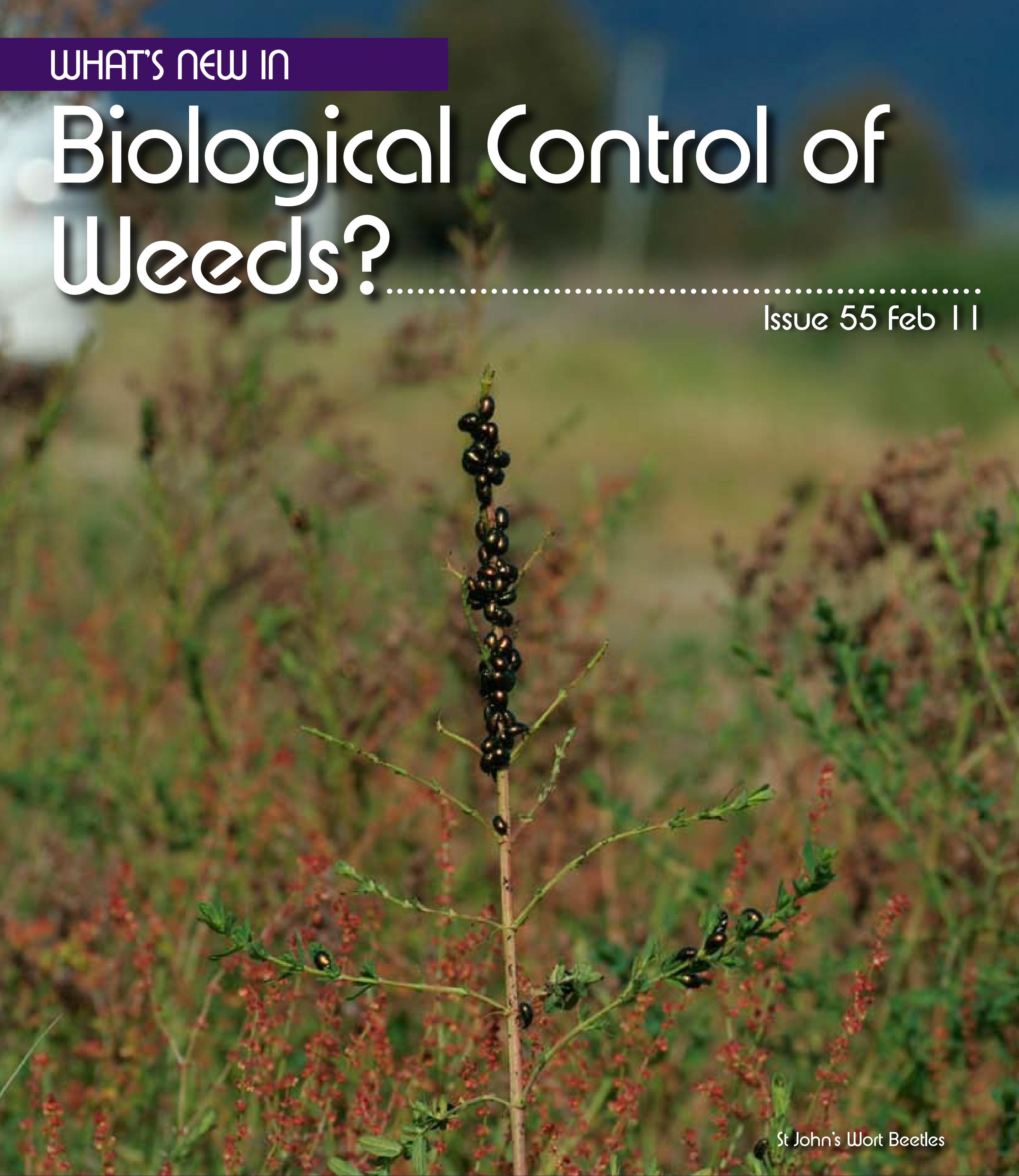

St John's Wort Beetles

What's Inside?

Landcare Research
Manaaki Whenua

Tradescantia Beetles out of Containment

After 2 years of intense effort, disappointment and frustration, we are delighted to finally announce the tradescantia leaf beetle (*Neolema ogloblini*) is free of the gregarine gut parasite that has plagued it for so long (see *Tummy Bug for Tradescantia Beetle*, Issue 50). Lindsay Smith and Simon Fowler have worked hard line-rearing from individual female beetles and it has finally paid off. We already had permission from ERMA to introduce the species, so once it was confirmed the population we held was gregarine free, MAF gave permission to release the beetles from containment. This enabled Lindsay to hand-carry on Christmas Eve a precious 80 pupae and adults to Chris Winks in Auckland for mass-rearing. "We have seen larval feeding damage already so they seem to be settling in well," said Chris. With luck it won't be long before we have enough beetles for the first field release – hopefully this autumn. Widespread releases will be made as soon as it is possible to do so. We still have a few leaf beetle breeding lines in containment that, if clear of the parasite, will be used to boost Chris's rearing colony.

Auckland Council has applied to ERMA for permission to release two further tradescantia agents, the tip-feeding (*Neolema abbreviata*) and stem-boring (*Lema basicostata*) beetles, and we hope to have an answer within 6 months. As previously reported, routine disease tests found low levels of different species of gregarines in both beetle populations. We are confident the methods used to rid the leaf beetle population of the parasite will also work for the stem-borer and tip-feeder.

To eliminate the gregarine parasite from the leaf beetle population we adopted high levels of hygiene for adults and newly laid eggs, reducing the likelihood of infection, and low levels of hygiene for developing larvae. "By not keeping things too clean at this point any parasites that may be present are given the greatest opportunity to express themselves, e.g. as a sick/dying larvae or adult, since they can be difficult to detect when present at low levels," said Lindsay. Any eggs or offspring from sick adult beetles can then be culled. All this information is recorded, e.g. we have full family trees for all of the leaf beetles and can trace each back to their great grandparents! This also helps to reduce inbreeding. We hope that by the end of the year we will have gregarine-free populations of the stem-borer and tip-feeder and permission to start making releases. We have pursued this trio despite the parasite problems because they attack different parts of the tradescantia plant (leaves, stem, stem-tips) and should make a complementary team. Defoliation experiments indicate that the sum effect of their feeding will be magnified in the presence of each other. Just wait until we get them out there!

Meanwhile, work is continuing in Brazil with a fourth promising agent, the yellow leaf spot fungus (*Kordyana brasiliense*). We are still trying to get around difficulties with infecting plants with the disease. "Our colleague in Brazil, Dr Robert Barreto, has had to resort to hanging infected plant material upside down above test plants and waiting for the fungus spores to fall down and infect them!", said Lindsay. None of the other more usual methods for inoculating plants have worked. While this unorthodox method works fine, and all host-testing has been completed, it creates problems for when we need to import a pure culture of the fungus into New Zealand. Importing infected whole plants rather than individual spores causes difficulties because the plants may be infected with other pathogens. We are currently working with MAF to design an acceptable protocol for importing *Kordyana*-infected plants that can then be maintained in quarantine to check that no other unwanted pathogens have hitched a ride. We are currently exploring the possibility of building a pathogen containment facility at our Auckland site to undertake this and other biocontrol work.

Further work on another stem-boring beetle (*Buckibrotica cinctipennis*) is on the back burner while we are focussing our attentions on the trio of beetles described earlier.

This project is funded by the Department of Conservation, National Biocontrol Collective and the Ministry of Science and Innovation under the Beating Weeds programme.

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Adult stem-boring beetle.

First Woolly Nightshade Lace Bug Release

The first biocontrol agent for woolly nightshade (*Solanum mauritianum*) has now been released in New Zealand. “In November we released the woolly nightshade lace bug (*Gargaphia decoris*) in a forestry block in Tauranga,” said Chris Winks, who is in charge of mass rearing them. Environment Bay of Plenty applied to ERMA to release the lace bugs so it was fitting that they got the first release. Since then releases have been made in Waikato, Taranaki, Northland, Manawatu-Wanganui, and at other sites in the Bay of Plenty. More widespread releases are planned.

We are looking forward to the lace bugs settling in and feeding on woolly nightshade. Having seen the potential for serious damage they have demonstrated in South Africa (the only other place where they have been released for biocontrol) and knowing that there will be less pressure from predators here, we are expecting great things! The next step in the biocontrol programme will be to work towards releasing a second agent, which is likely to be a tiny weevil (*Anthonomus santacruzi*), which feeds on the flower buds.

First release of woolly nightshade lace bugs.

This project is funded by a National Collective of regional councils and the Department of Conservation.

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Weedy Workshops

If there is sufficient interest we will hold an advanced biocontrol workshop in Auckland at the end of March. The aim of this workshop is to give people the skills and confidence to manage their own biocontrol programmes. It is ideal for people who have a reasonable knowledge of weed biocontrol and ideally have undertaken our basic training workshop two or more years ago. We build on existing knowledge and bring people up to speed with new developments. If your organisation contributes to, or supports, our research in some way then there is no charge. If not you may still be able to attend, if there are places available. If you are interested in attending this workshop please contact Lynley Hayes.

CONTACT: Lynley Hayes (hayesl@landcareresearch.co.nz or Ph 03 321 9694)

We are also aiming to hold another one-day Biosecurity Bonanza, this time in Auckland in June. You will be able to choose between two concurrent sessions as this workshop includes talks on mammal pests as well as the latest weeds research. There is no charge to attend this workshop. If you would like to be sent further information about the date, venue and programme please contact Andrea Airey (aireya@landcareresearch.co.nz).

International Symposium on Biocontrol of Weeds

The XIII International Symposium on Biological Control of Weeds (ISBCW 2011) will be held in Hawai’i in September. This symposium is the most important gathering of scientists and managers working on biocontrol of weeds in the world and is held every 4 years. The International Bioherbicide Working Group is also holding a one-day meeting in conjunction with the symposium. A group from our Biocontrol of Weeds team will be flying the flag for New Zealand and presenting a range of talks on our work. If you are interested in the symposium see http://uhhconferencecenter.com/xiii_isbcw.html for more information.

Learning Lessons for the Future from the Past

St John's wort (*Hypericum perforatum*) became a serious pasture weed in New Zealand in the 1930s and could not be managed with the conventional control tools of the day. Successful biocontrol of the weed in Australia by the lesser (*Chrysolina hyperici*) and greater (*C. quadrigemina*) St John's wort beetles led to their introduction in 1943 and 1965 respectively. Biocontrol of St John's wort in New Zealand has also been spectacularly successful, but recently there have been concerns that this may have come at a cost to native *Hypericum* species. Host-testing of the beetles in Australia, while considered sufficient at the time, did not include other *Hypericum* species, let alone any indigenous to New Zealand. Studies from California, Canada, Australia and New Zealand have shown that both St John's wort beetles can attack a range of *Hypericum* species in the field and are not just restricted to St John's wort – hence the concern.

One of our native *Hypericum* species, *H. pusillum*.

In New Zealand we have four native *Hypericum* species: *H. gramineum*, *H. pusillum* (both shared with Australia and South East Asia), *H. rubicundulum* (endemic), and *H. minutiflorum* (endemic and classified as critically threatened). The latter three species designations are the result of a recent taxonomic revision that split up what was known previously as *H. japonicum*. "We have recently conducted retrospective host testing and the results show that both beetles can attack three of the native *Hypericum* species," said Ronny Groenteman, who led the work. *H. minutiflorum* was not tested as, being rare, it could not be sourced for the study. During no-choice tests larvae of both beetles attacked whatever *Hypericum* species was presented to them; there was no significant difference between feeding on St John's wort and the non-target species. In terms of development, about half (lesser beetle) to two-thirds (greater beetle) of larvae were able to complete development into adults on St John's wort and *H. gramineum*. A smaller proportion completed development on *H. pusillum*, although took significantly longer. Both beetles laid eggs on all three native *Hypericum* species in no-choice tests. During choice tests, the greater St John's wort beetle laid significantly more eggs on native *Hypericum* species than on St John's wort.

Given the standards required for host-specificity of biocontrol agents today, these results would lead to considerable caution. It is likely that an application for release would not be made given that the Hazardous Substances and New Organisms Act (HSNO) 1996 explicitly excludes organisms that are "... likely to cause any significant displacement of any native species within its natural habitat".

However, we know that testing in the laboratory can overstate what might happen in the field and there is a real danger of rejecting potentially useful agents. Additional information and/or testing methodologies can help tease out the real risk to non-target plants. We may need to increase the degree of realism in choice tests. Increasing the size of the test cage or conducting field tests in the native range might help in some cases. We may also need to determine whether the risk of non-target feeding is only from local spillover attack, e.g. a sustaining/damaging population cannot be created on the plant, and only occurs in close proximity. For example, it was noticed in the early days that the beetles would attack the exotic weed tutsan (*Hypericum androsaemum*) and adult lesser St John's wort beetles were even released specifically on this plant in the 1940s, but never established. Indeed, the current study has shown that tutsan is a sub-optimal host on which the beetles cannot complete a full life cycle, so any attack is transitory and of no consequence to the plant in the longer term. "While we know that damage to native *Hypericum* species is possible, so far our field surveys suggest that the impact of the St John's wort beetles on native *Hypericum* populations in reality has been and remains low to absent," said Ronny. The host tests are overstating what happens under more natural conditions. Phew!

This study provides some important lessons for the future. The biocontrol of St John's wort is one of the most successful weed biocontrol programmes in New Zealand, but had present-day risk assessment protocols been strictly adhered to the beetles might not have been introduced. It seems unlikely that native *Hypericum* species have suffered as a result of releasing the beetles and, along with other native species, might have been harmed more by the St John's wort invasion had it not been adequately controlled. Other more specific biocontrol agents for St John's wort exist – such as the gall midge (*Zeuxidiplosis giardi*) introduced in 1960–61, which only established in the Nelson region – but the control of the weed using these might have been less successful and taken a lot longer. This project reminds us not to be too quick to reject promising potential agents, but to carefully identify what else we need to find out in order to more accurately assess the risks and benefits such an introduction might pose.

This work was funded by the Ministry of Science and Innovation under the Beating Weeds programme.

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Autumn Activities

Before settling down for a break over winter there are a few things you might want to do:

Boneseed leafroller (*Tortrix* s.l. sp. "*chrysanthemoides*")
Check release sites for feeding shelters made by caterpillars webbing leaves together at stem tips. Caterpillars are olive-green when small and become darker with rows of white spots as they get older. Do not harvest caterpillars until spring. We would be very interested to hear if you find large numbers and/or damage.

Broom gall mites (*Aceria genistae*)
While it may still be too soon at many release sites, should you find high numbers of galls, early spring or autumn is the best time for redistribution. Look for hairy deformities, which appear almost white in colour and range from 5 to 30 mm across. Aim to shift at least 15 galls by tying 3–5 galls per bush onto plants at the new site so the tiny mites can move across. We would be very interested to hear if you find any galls, especially large numbers.

Galls on broom caused by the gall mite.

Gorse pod moth (*Cydia succedana*)
Check pods for the creamy-coloured caterpillars and/or their granular frass. Small entry/exit holes may also be seen in the pod wall. This agent is widespread but can be redistributed by moving branches of infested pods.

Gall-forming agents
Check release sites of gall-forming agents. Early autumn is a good time to find galls caused by the **mist flower gall fly** (*Procecidochares alani*), **hieracium gall midge** (*Macrolabis pilosellae*) and **hieracium gall wasp** (*Aulacidea subterminalis*). If you find abundant galls you could harvest mature ones and release them at new sites. The exception, however, is the hieracium gall midge, which is best redistributed in the spring. Do not collect galls from mist flower that have windows in them as the new adults have already emerged.

Nodding and Scotch thistle gall flies (*Urophora solstitialis* and *U. stylata*)
Check release sites for fluffy-looking flowerheads, which feel hard and lumpy when squeezed. To redistribute, collect infested flowerheads and put them in an onion or wire mesh bag. Hang the bag on a fence at the new release site. Over winter the galls will rot down and adult flies will emerge in the spring.

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

Buddleia Leaf Weevil – Dispersing and Damaging

It has been 4 years since the buddleia leaf weevil (*Cleopus japonicus*) was first released and the time is right for a closer look at its impact on the weed. While buddleia (*Buddleja davidii*) grows in many different environments, the push behind the biocontrol programme has come from the forest industry. Buddleia is estimated to cost the industry up to $2.9 million a year in control costs and lost production. The problem is that the fast-growing weed outcompetes newly planted pine (*Pinus radiata*) trees causing reduced growth and increased mortality. The trees are most vulnerable to competition during the first 5 years after planting. Research shows that both buddleia height and leaf area must be reduced if its competitive advantage is to be lessened. Trials indicate that if over 30% of buddleia foliage can be removed then there is likely to be a significant reduction in height. If the leaf weevil is going to be effective at managing buddleia in pine plantations, it needs to disperse into newly planted areas, build up to damaging numbers, and cause significant damage within 5 years. Although these statistics were calculated for buddleia in pine plantations, they are still a good target to aim for, and measure the weevils' success against, in other buddleia-infested environments.

Since its release in 2006 the buddleia leaf weevil has established at over 30 sites, predominantly in the North Island, but also in Canterbury and the Tasman area. It has great potential for fast population growth as the adults are fairly long-lived (up to a year) and females can lay up to 20 eggs a day. The result is overlapping generations with adults, larvae and eggs all present at the same time. Monitoring of the oldest release sites shows that weevil numbers increased significantly every year. Despite the high numbers, they were initially slow to disperse. "It appears that it took high population numbers and the resulting deterioration of their food plants to trigger adults, which are good fliers, to move on," said Michelle Watson of Scion, who is currently leading the project. Dispersal rates from the original release sites ranged on average from 30 to 100 m over 6 months (measured over 3 years). However, having got going they are dispersing well. "In Whakarewarewa Forest, for example, the weevils have spread right throughout the area all by themselves, a distance of up to 50 km in 4 years," said Michelle.

The damage caused by the buddleia leaf weevil is most dramatic in autumn. At the oldest release sites most plants are almost completely defoliated. Unfortunately, this is after the weed has set seed and so may not reduce seed production. Buddleia is also very good at recovering from heavy browsing. It appears that sustained pressure is needed to get on top of the weed. Monitoring at Kinleith Forest shows that after three consecutive years of almost complete defoliation by the weevils there is a significant reduction in plant regrowth, with some plants barely producing any new leaves. There is also a noticeable reduction in overall flower production.

To look more closely at buddleia leaf weevil behaviour, researchers set up a field trial that mimicked the conditions of a newly planted forest – small buddleia plants and open ground. Once the buddleia seedlings were planted it took around 3 months before weevils were found on them. This lag could be due to adult weevils' ability to locate the plants or their motivation to move to a new host. "The latter seems most likely as the plants where they were placed at the start of the trial had become heavily defoliated by this time, with up to 90% of total leaf area removed," said Michelle. The weevils dispersed at a rate of about 100 m per year. There was a significant relationship between the percentage defoliation

Buddleia defoliated by the leaf weevil.

and the total number of larvae, but not adults, present. This implies that although both life stages feed on buddleia leaves, larvae are the most damaging. In terms of damage, there was a lag of approximately one year between weevils dispersing onto the new buddleia plants and their feeding causing more than 30% defoliation. After 15 months, plants that were not protected from the weevils were significantly shorter – by 19% – than those that had been sprayed with insecticide. These findings show that the buddleia leaf weevil has the ability to damage buddleia within the short window of time needed to prevent the weed from out-competing pine trees in plantation forestry. These same characteristics will also serve it well when attacking buddleia in other environments.

This work is funded by the Ministry of Science and Innovation and the forestry industry.

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Classical Biocontrol for Nature Conference

Debate on how to balance the risks and potential benefits of classical biocontrol (where an agent is sourced from the target species' home range – the kind of biocontrol we mostly use in New Zealand) has been rather one-sided, with most publications emphasising the potential negative effects of agents introduced to control invertebrates and weeds. At least, that was the case until last year when a major paper looked at the benefits gained by natural ecosystems world-wide from the introduction of biocontrol agents (Van Driesche et al. 2010). This global, multi-authored review covered the biocontrol of both weed and insect pests and analysed programmes in three benefit areas, protecting either biodiversity, resources or ecosystem services. Globally for weeds, 49 projects were identified as having benefits to indigenous systems. Almost all of these (98%) provided benefits to the protection of biodiversity and 25% preserved ecosystem services. The paper featured two pieces of research led by New Zealand practitioners: the biocontrol of mist flower (*Ageratina riparia*) in New Zealand and the biocontrol of an exotic scale insect threatening endemic plants on islands in the Atlantic (based on Simon Fowler's work with CAB International). The review concluded that there is an increasing need for biocontrol programmes in natural ecosystems and that these need to be professionally monitored and involve a multidisciplinary team.

The review led on to the Biological Control for Nature conference in the US in October, held to explore the benefits of classical biocontrol for the control of invasive insects and plants in natural ecosystems. Simon Fowler, Quentin Paynter and Jane Barton were invited speakers. Simon reported on the recovery of native vegetation after the biocontrol of mist flower, and how to assess the benefits of weed biocontrol, highlighting different monitoring methods. He also co-organised the session on biocontrol of invasive species on islands. Quentin spoke on integrating herbicide, mechanical, and fire control methods with biocontrol to manage a woody wetland weed (*Mimosa pigra*) in Australia (based on his work with CSIRO, Darwin). Jane's talk was on pathogens used worldwide as weed biocontrol agents and the predictability of their behaviour post-release (see below). (Note this talk will be repeated at the New Zealand Biosecurity Institute's National Education and Training Seminar (NETS) later this year).

Two key papers that sparked the "risks vs benefits" debate were written by Dr Dan Simberloff (University of Tennessee ecologist) and Peter Stiling (University of South Florida). They questioned the thoroughness of risk assessment associated with biocontrol and hence, became famous (infamous?) in the biocontrol community for making regulators more nervous about using the method. Dr Simberloff bravely attended the conference and gave an interesting talk explaining his concerns with respect to "risk assessment". His main point is that biocontrol has inherent risks, many of which (especially downstream impacts) are unpredictable and unquantifiable. He thought biocontrol practitioners needed to be more up-front about admitting that. In response, audience members pointed out that regulators seemed to expect researchers to predict these unpredictable things, and that biocontrol is over-regulated. (Note that we disagree that it is overregulated in New Zealand.) The debate was amicable and no doubt both sides learnt something. The opportunity for face-to-face debate such as this makes conferences so valuable to scientists. Dr Simberloff's main concerns are about the use of non-specialist insect predators and parasitoids for control of invertebrate pests; during the discussion he conceded he was generally satisfied with host-range testing procedures for weed biocontrol agents.

The skeleton weed rust fungus has been released in the US.

The New Zealanders were consequently concerned to discover that weed biocontrol in the US has almost ground to a halt. “We were surprised to hear how difficult it is to get permission to release new agents there,” said Quentin. The complex bureaucracy that programmes have to go through to get permission for release seems partly to blame. Multiple agencies are involved in decision-making and the system for approving agents for arthropod pests is different to that for weeds. There are instances where potential agents, despite being highly specific in host-testing, have still been rejected for release. New Zealand has a very different system. Our process, where the Environmental Risk Management Authority (ERMA) is responsible for approving releases of new organisms under the Hazardous Substances and New Organisms Act, is recognised as world-leading. “The critical benefits of the ERMA system are public consultation and openness, as well as being apolitical,” said Simon.

Reference

Van Driesche RG, Carruthers RI, Center T, Hoddle MS, Hough-Goldstein J, Morin L, Smith L, Wagner DL, et al. 2010. Classical biological control for the protection of natural ecosystems. Biological Control Supplement 1: S2–S33

Biological Control for Nature conference programme and PowerPoint downloads available at http://biocontrolfornature.ucr.edu/program.html

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Pathogens underused as biocontrol agents in the US?

Pathogen agents for the biocontrol of weeds appear to be well behaved. “Those released against weeds worldwide have so far behaved as predicted by pre-release host specificity research,” said Jane. Despite this excellent safety record, both Jane and Dr Bill Bruckart (US Department of Agriculture pathologist) noted that pathogens have been used much less often than insects as biocontrol agents in the US. “It seems that regulators in the US are risk-averse and particularly nervous about pathogens – despite success stories such as the use of the leaf smut, *Entyloma ageratinae*, against mist flower in Hawai’i,” said Jane. Pathogens appear to be primarily selected for low risk and not necessarily high benefit in the US. It was observed over 25 years ago that there is an air of “pathophobia” impeding the use of plant pathogens for weed control in the US and this probably still applies today. In the past there have been many releases of insects against weeds on the US mainland, but only a few pathogens have been released. One project released the rust fungus *Puccinia chondrillina* against skeleton weed (*Chondrilla juncea*), following its successful use in Australia, and two others have targeted thistles with close native relatives. “I hope my talk will reassure Americans that pathogens are a safe and underused tool for weed biocontrol,” concludes Jane. Fortunately pathophobia is not a big issue for us in New Zealand.

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