

WHAT'S NEW IN

Biological Control of Weeds?

Issue 69 August 14

Woolly nightshade devastated by lace bugs

Andrew Blayney

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Landcare Research
Manaaki Whenua

Lace Bug Does Best in Shade

Since the first release in November 2010, the woolly nightshade lace bug (*Gargaphia decoris*) has been released widely throughout New Zealand. The lace bug has established readily at many sites, but it became clear early on that predation was possibly going to prevent it from achieving its full potential.

However, in June we received reports of some spectacular damage in the Bay of Plenty. Heavy damage through to total defoliation of woolly nightshade plants was observed over an estimated 15-ha area in the Ngapeke Forest Block. This estimate is based on only what can be easily seen from tracks so the damage is expected to be present over a much larger area. By contrast nearby plants in open areas remain healthy. The photos sent to us looked uncannily like those of a major lace bug outbreak in South Africa, which also occurred where woolly nightshade plants were growing under pine trees. Unfortunately that site was destroyed by fire soon after the outbreak and could not be studied further. Lace bugs have been established in South Africa for 15 years but populations have mostly remained at low levels due to predation of the immature life stages. We shared the Ngapeke Block photos with our collaborator in South Africa, Dr Terry Olckers (University of KwaZulu-Natal). Terry told us that one of his students had recently done some work confirming that the lace bugs do best in partial shade.

In the South African study potted plants were grown in a shade house to ensure uniformity of size and quality before being put out in either full sun, partial shade or full shade. The plants were inoculated with 20 adult lace bugs, and monitored daily for 2 weeks. Other plants were inoculated with a batch of newly-hatched nymphs, which were left undisturbed for a week and then monitored daily for 4 weeks. Because the early instars are most susceptible to predation, all generalist arthropod predators were collected after the first week to gain some insight into their abundance but were then left undisturbed. During the 2 weeks that

the adults were monitored, numbers declined steadily in all three treatments due to dispersal. The nymphs also steadily declined, with few reaching adulthood. "Partially shaded locations consistently proved to be the most suitable for both life stages, with fully shaded locations the least suitable," confirmed Terry. Partially shaded sites had on average the least predators. These results, combined with the field observations in both countries, suggest that any further releases of the lace bug should target partially shaded woolly nightshade infestations to increase the chances of establishment and impact.

Meanwhile efforts are continuing to find other woolly nightshade biocontrol agents for New Zealand. After the flowerbud-feeding weevil (*Anthonomus santacruzii*) failed host testing by unexpectedly completing development on poroporo (*Solanum aviculare*) in a field test in South Africa, it was back to the drawing board. As Terry had no immediate plans to develop new agents, we contacted the collaborator in Brazil who had originally assisted him (and helped us more recently with our tradescantia project). Professor Henrique Pedrosa Macedo (University of Paraná) agreed to help and we drew up a plan.

Based on previous experience with other woolly nightshade insects, host-testing is likely to be complex and require field trials. "We therefore decided to move directly to field testing in Brazil rather than attempting to undertake testing in containment in New Zealand, which might provide ambiguous results, and ultimately see us still needing to undertake field trials," explained Simon Fowler. This meant setting up test gardens in Curitiba. Most test plants could be sourced in Brazil but we needed to ship over seeds of poroporo (*S. aviculare*, *S. laciniatum*). The poroporo plants were initially grown in a containment facility in Brazil to check for disease, but have now been planted out ready for trials to begin as soon as insects are available. Unfortunately, due to unusual weather conditions in Brazil last spring/summer, the insects we wish to test were unusually rare and could not be collected in sufficient numbers. The species of interest include a yet to be identified gall-former, another flowerbud-feeding weevil (*Anthonomus morticinus*) that may be more tightly host specific than the failed *A. santacruzii*, and a stem-boring weevil (*Conotrachelus squalidus*). Simon will visit Brazil in November to assist with field surveys and establishment of the field trials.

This project is funded by the National Biocontrol Collective.

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Andrew Bleyney

Woolly nightshade plants completely defoliated by the lace bug.

Untangling the Food Web Inside Broom Galls

Gall mites (*Aceria genistae*) were introduced to New Zealand from France and released in 2008 to damage broom (*Cytisus scoparius*) stems and reduce their vigour. When biocontrol agents are established it is inevitable they will interact with many more organisms than just their target weeds as they become part of new food webs. In Issue 57 we reported finding that the gall mites were carrying microbial spores. At the time, it was not known whether these microbes were fungi or bacteria and whether they were helping or hindering the activity of the gall mite. Researchers wanted to explore whether there is a synergistic relationship between the microbes and the gall mites that is important in gall formation, and therefore whether they play a role in regulating the growth of the broom. “We are always interested in learning what makes some agents more successful than others so we can make better agent choices in the future,” said Zhi-Qiang Zhang, the acarologist leading this project.

Several years down the track, and after input from a range of scientific disciplines, we have learnt that there are a diverse range of microbes associated with the broom galls and gall mites in New Zealand and similar genera in France. Chantal Probst collected galled stems from broom plants in both countries. Using DNA analysis she isolated more than 80 genera of fungi, yeast and bacteria from the New Zealand samples and almost 50 genera from the French samples (which were also fewer in number), a much higher diversity than expected. Pinpointing the origin of the microbes found on the New Zealand plants, although desirable from a biosecurity perspective, was not possible since there is no historical record of which microbes occur naturally in New Zealand to use as a reference.

The next question was whether the microbes were pathogenic to the broom plants. Experiments were designed to determine if the common microbes could form galls themselves, in the absence or presence of the gall mites. “Secondary to this, we needed to determine whether the microbes affected the growth and survival of the plant in any way,” explained Zhi-Qiang. This work was done in two phases: firstly in glasshouses and then using field studies based in North Canterbury. In phase one young broom plants were inoculated with fungi (two species of *Fusarium* and one species of *Phoma*) and one species of bacterium (*Pantoea*) extracted from broom galls. These were compared with three different controls, which included a positive inoculation with a known pathogen (*Fusarium tumidum*). There were five replicates of each treatment and the experiment was repeated three times. The results indicated that, after



Broom inoculation experiment.

6 weeks, there was no difference in the growth rate of the inoculated plants and the control plants that were untreated. There were no galls visible either, suggesting that the isolates were not able to induce gall formation in the absence of the mite within this time frame.

Phase two is currently underway at a trial site on Leslie Hill Station near Hanmer Springs. At this site, the number of fungal isolates, the abundance of gall mites and the number of predatory mites (that reduce the number of gall mites) are being manipulated. Early results indicate that the gall mites are doing a good job of inducing galls on the broom, which is leading to lower plant survival. The broom gall mite is under attack from predatory mites, but broom plants treated with a miticide that specifically targets predatory mites (therefore allowing the gall mite populations to increase in abundance) did not appear to be adversely affected in terms of survival. Despite the predatory mites, the broom gall mites are still able to perform well. The galls offer some protection to the broom gall mites, and it appears that predatory mite numbers build up too late in the season to have a major impact. However, if mites are to be shifted to new sites, establishment success is likely to be greater if done early in the season (October–December) before predator numbers build up. Again no galls have been formed during the 2 years that the field experiment has been running, except by the gall mites, backing up the lab results suggesting that microbes are not involved in gall formation.

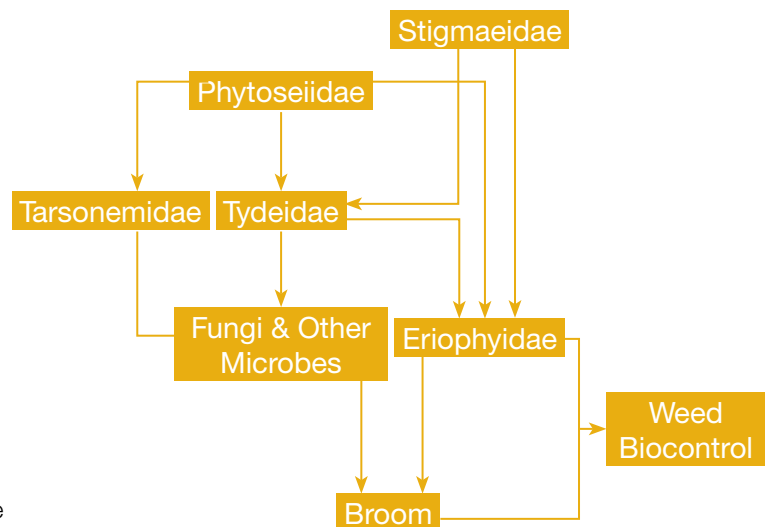
“The overall food web associated with broom galls has proved quite difficult to untangle,” said Zhi-Qiang. We have confirmed that there are fungivore–fungi–plant interactions



Broom gall mite galls.

and predatory-prey-plant interactions going on, in what is known as a reticulated trophic web, linked by polyphagous mites (see graphic). “There are still many complexities to unravel before we are able to determine the true relationship between the microbes and the gall mites,” remarked Quentin Paynter. It is possible that the microbes only attach themselves to the mites once they have been blown onto the plant and they are literally hitching a lift on the body of the mite to the part of the plant that they can infect. This was supported by the results shown from the glasshouse experiments and would definitely mean that the relationship between the microbes and the mites has an important beneficial effect on broom control. A logical extension to this research would be to confirm the role of the microbes found, but given their diversity, this could take a considerable amount of time and funding, so opportunities for students to undertake this research are being explored.

This research was funded by the Ministry of Business, Innovation and Employment as part of Landcare Research’s Beating Weeds Programme and Capability Funding.



Reticulated trophic web associated with broom gall mite galls.

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Leu, friend or foe for Broom Biocontrol?

In May last year (Issue 64) we reported on the recent discovery of “*Candidatus Liberibacter europaeus*” (Leu), a new and possibly pathogenic bacteria affecting broom (*Cytisus scoparius*). This bacterium can’t be cultured and can only be identified using modern molecular techniques. It is thought to have been introduced along with the broom psyllid (*Arytainilla spartiophila*) in 1993. At that time, these organisms were unknown to science, although disease symptoms had been apparent in crops such as potatoes and citrus

for many years, e.g. “zebra chip” potatoes in the USA. The discovery of these organisms, and the ability to identify them using molecular techniques, has led to an explosion of work worldwide as scientists try to protect valuable crops.

Landcare Research scientists have been collaborating with Plant & Food Research and Lincoln University to learn as much as possible about how Leu affects broom plants and how it is transmitted. It is not clear whether damage seen

on broom when significant psyllid populations are present is due to the psyllids (as previously assumed), Leu, or both. “A survey has shown that Leu is widespread on broom plants in New Zealand but only occurs in places where the broom psyllid has established,” said Simon Fowler who has been working on the project. Additionally, psyllids taken from the original collection sites in the UK were positive for Leu and the DNA matched the New Zealand Leu samples. “This leads us to believe that there is a strong likelihood that Leu did hitch-hike a lift to New Zealand on the broom psyllids brought out from the UK to control broom. However, at that time the insects were not able to be screened for this disease since we did not know it existed nor had the tools to find it,” said Simon.

“It is a bit of a double-edged sword,” explains Simon. “On the one hand we are pleased that the broom could be suffering due to the presence of Leu, but on the other, we have concerns that other psyllid species (either native or exotic) might probe the broom and become infected, which would potentially lead to other plant species becoming exposed to Leu. We have discovered that a range of psyllid species can be found on broom and kōwhai (*Sophora microphylla*), which is the closest native relative of broom in New Zealand. For example, despite being highly host specific, we have found broom psyllids sitting on kōwhai and surprisingly, kōwhai psyllids (*Psylla apicalis*) sitting on broom,” said Simon. There is no evidence to suggest that the broom psyllids are attacking kōwhai or that the kōwhai psyllids are attacking broom, but they may occasionally be probing these plants to test them out. “We detected Leu in two individual kōwhai psyllids that were collected from kōwhai plants, which, despite being only a small proportion of the total number of psyllids tested, is still cause for concern,” he added. It isn’t known whether these infected kōwhai psyllids would be able to transfer the pathogen to kōwhai. Investigations in collaboration with Plant & Food Research have been unable to detect Leu in kōwhai. “It is comforting to confirm that Leu isn’t prevalent in kōwhai psyllids, and even more comforting that we haven’t been able to detect Leu in any of the kōwhai tissue samples tested,” said Simon. “These are just preliminary results and more sampling is required to confirm our findings, but kōwhai has had over 20 years’ exposure to the broom psyllids so we might have expected to detect Leu and see symptoms by now if the psyllids had transferred it to kōwhai trees,” Simon said. A PhD student at Lincoln University has just started to investigate whether other psyllids in New Zealand are carrying novel indigenous “*Ca. Liberibacter*” species. So far only six species of Leu have been discovered worldwide, but there is a lot at stake because of their devastating effect on horticultural crops.

“A longer term question for us is whether we should continue to use sap-sucking insects like psyllids as biocontrol agents,

and whether psyllids are likely to transfer “*Ca. Liberibacter*” from broom to other plants,” said Simon. To help answer the latter question and better understand how the psyllids vector “*Ca. Liberibacter*”, a series of experiments have been established at the Landcare Research campus in Lincoln. The aim of these experiments is to determine whether Leu is a harmless endophyte (symptomless) or not. Studies undertaken by Plant & Food Research have shown that a similar bacterium (“*Candidatus Liberibacter solanacearum*”) can be symptomless in some plant species but not in others. The Italian scientists that originally discovered Leu in pear trees consider it to be a harmless endophyte. If this is the case, the implications for biocontrol concern whether we are able to predict which plant species are likely to be symptomless and which are not. If psyllids do not depend on the presence of the “*Ca. Liberibacter*” to cause damage to weeds, it will be possible to line-rear imported psyllids prior to their release to eliminate any trace, but this will be costly and time-consuming. “So far the experiments have not given us any definite clues, but then it is not known how long it takes for the disease to establish in the plants or how long it takes for the symptoms (if any) to become apparent,” concluded Simon. In any case, the experiments will need to run for some time, since the psyllids reproduce slowly with only one generation a year and to ensure that the test plants are infected.

This research was funded by the Ministry of Business, Innovation and Employment as part of Landcare Research’s Beating Weeds Programme.

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Kōwhai psyllid.

Size Does Matter

The broom seed beetle (*Bruchidius villosus*) was released in New Zealand in 1988 to help manage infestations of Scotch broom (*Cytisus scoparius*). The larvae of this beetle live inside the tough little seeds and eat out the contents, destroying seeds and reducing germination rates. Even though the beetle has been estimated to destroy about 75% of seeds here now, models suggested that this was unlikely to be sufficient to reduce broom populations alone. However, Quentin Paynter presented a talk at ISBCW reassessing these predictions, looking at the *quality* of seeds produced by the broom plant instead of their *quantity*.

In its home range (Europe) broom relies on disturbance to regenerate or it disappears, but not so in New Zealand where seedlings happily grow up below existing stands, ensuring populations are perpetuated. There is evidence to suggest that big broom seeds are more successful at producing seedlings that can survive and grow in the shade of existing stands. Studies have shown that, on average, broom seeds in the native range are smaller than broom seeds in the introduced range. Quentin and his colleagues have collected and weighed broom seeds from 14 locations around New Zealand. “The seeds were highly variable in size but still on average around 40% bigger than their European counterparts, which helps explain why broom is so invasive here,” said Quentin.

Quentin has discounted the possibility that the increase in seed size is due to founder effects or genetic drift. He has suggested though that evolution may be responsible for the change, with seed size gradually becoming bigger in the exotic range because of an absence of seed beetles.

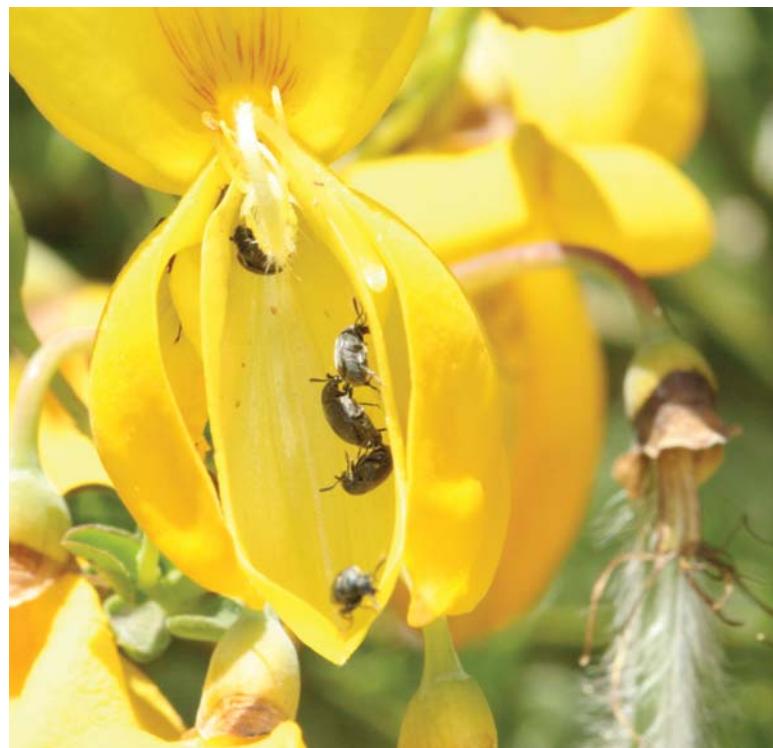
This is because seed size has implications for the seed beetles. The larger the seed, the larger the beetle that emerges, and larger beetles are more successful at surviving winter and producing offspring. Quentin measured the size of the broom seed beetles emerging from different sized broom seeds, confirming a strong positive correlation between seed size and beetle size. “I also found that on average the largest females laid over three times more eggs than the smallest and that large beetles were better at surviving the winter than small ones,” confirmed Quentin.

Thinking ahead it is possible to imagine a scenario where the New Zealand seed beetles may over time create a selection pressure that favours broom plants that produce small seeds, as these will reproduce more successfully than the

big-seeded plants favoured by the beetles. This could result in less competitive broom like that seen in the native range. However, the broom seed beetle would not do as well under that scenario so biocontrol could break down, potentially allowing broom to bounce back again. However, if this was to happen, another seed-feeder that does not appear to rely on large seeds is available that could be introduced to New Zealand. Larvae of the broom seed weevil (*Exapion fuscirostre*) feed externally on multiple seeds and are therefore not affected by seed size, and would be fine regardless of seed size. Also, with the way the broom gall mite (*Aceria gentistae*) is performing, many broom plants may in future not survive to produce much if any seed. We will continue to monitor broom seed size in New Zealand every 5–10 years to see if changes are occurring and so we know if any other actions will be needed to stay on track with our goal to successfully biologically control broom.

This research was funded by the Ministry of Business, Innovation and Employment as part of Landcare Research's Beating Weeds Programme.

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Broom flower containing seed beetles of various sizes.

Tales from the Plant ID Service

The Allan Herbarium at Lincoln is a treasure trove of over half a million pressed and mounted plants and lichen specimens. “This nationally significant collection underpins biodiversity and biosecurity research and management in New Zealand,” explained Ines Schonberger, who oversees the day-to-day operations. Earliest specimens are from 1769, collected by Banks and Solander during Captain Cook’s first voyage to New Zealand. While the key focus is on New Zealand plants, the herbarium has specimens from all over the globe.

The herbarium plays a vital role in weed management via its Plant Identification Service. Every year the herbarium receives more than 800 specimens for identification. “Some of the specimens are sent in by enthusiastic members of the public, but most specimens are sent in from agencies concerned with biosecurity such as regional councils, the Ministry for Primary Industries (MPI) or the Department of Conservation. Each year there are some interesting finds.

Recently staff were asked to identify plants originating from seeds found in a shipment of bananas from Ecuador. These plants were identified as nettletrees (*Trema*) in reference to their superficial resemblance to members of the Urticaceae. *Trema* are fast-growing pioneer trees found throughout the tropics and subtropics. *Trema* species are not currently present in New Zealand but are known to naturalise easily and have the potential to become invasive weeds here. Definitely one to keep out of in warmer parts of the country!

AgResearch sent in some plant specimens that had been grown (in containment) from seeds in soil collected from a shipping container loaded somewhere in the Pacific region. “Most of the 25 specimens identified belonged to taxa previously not known from New Zealand, and several of these taxa have weed potential,” confirmed Ines. While it is important to identify taxa brought into the country by accident, it is also important to voucher them to create a permanent record for future reference.

“Sometimes it is difficult for people to distinguish between native and non-native species,” said Ines. “Many genera contain both native plants and exotic species, for example *Juncus edgariae* is an endemic rush and very similar to the weed *J. articulatus*. Likewise, *Carex dissita* is endemic to New Zealand and *C. longibrachiata* is a weed,” she explained. Occasionally, “weed” specimens sent in turn out to be native species.

As well as terrestrial plants, algae and aquatic plants are often sent in. Recently algae on felt fishing boots from the

Nettletree (*Trema* sp.)
grown from seed in a
banana shipment.



USA caused alarm at the border. “However, we were quickly able to confirm that the sample contained *Cladophora glomerata*, a widely distributed freshwater alga that is already known from New Zealand,” said Ines. Other aquatic plants, attached to stalks of garlic originating from China, were identified as being *Wolffia globosa*, a free-floating plant measuring only 1 mm across. *Wolffia globosa* is found in East and Southeast Asia, Africa and Australia and has not been recorded from New Zealand.

As well as specimen identification, there are always changes to the nomenclature and taxonomy to keep up with. “Being up to date on names is critical for those charged with ensuring compliance with legislation outlining what plants are permitted entry into New Zealand, what species can be propagated or sold here, and what weeds must be controlled according to pest management strategies.

Sometimes, it is just information that people are after. For example MPI approached the Allan Herbarium to find out whether black grass (*Alopecurus myosuroides*), a potentially nasty agricultural weed on their watch list, is in New Zealand. Herbarium staff confirmed having no recent records of black grass (only one from 1941 in mid-Canterbury) and could not find evidence of specimens in any other New Zealand herbarium. Staff strongly recommended that MPI ensured no material of this species is allowed into the country. That was shortly before the news of a major accidental black grass seed spill in Canterbury hit the news headlines. The herbarium will no doubt now play an important role in documenting the success of efforts to mop up the spill.

For guidelines for sending specimens to the herbarium see <http://www.landcareresearch.co.nz/resources/collections/allan-herbarium/services/plant-identification-and-information>

Funding to maintain the Allan Herbarium is provided by the Ministry of Business, Innovation and Employment. A small fee is generally charged to cover the cost of identifications.

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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.

Bridal creeper rust (*Puccinia myrsiphylli*)

Check bridal creeper infestations for bridal creeper rust, particularly sites where it has not been found before. Plants infected by the rust have yellow and black pustules on the undersides of leaves and on stems and berries. They may look defoliated and sickly.

- It is unlikely that you will need to redistribute bridal creeper rust because it is so widespread, but if you do, detailed instructions are available at <http://www.csiro.au/en/Outcomes/Safeguarding-Australia/Bridal-Creeper-Rust-Fungus.aspx>.

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. Occasionally galls can be found on broom that are not made by the gall mite, but these are much less dense. Also you may see galls on native broom that are caused by native gall mites. We are happy to help confirm the identity of any galls you find.



Bridal creeper rust

- 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 only found reasonable evidence of establishment 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.

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 begin harvesting and redistribution at some 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.

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, 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. The white, star-shaped pupal cocoons may be visible on damaged foliage.
- We would not expect you to find enough beetles to be able to begin harvesting and redistribution just yet.

Tradescantia stem beetle (*Lema basicostata*)

- Check release sites, especially the older ones. The black knobby adults also tend to drop when disturbed, but 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.
- We would not expect you to find enough beetles to be able to begin harvesting and redistribution just yet.

Tradescantia tip beetle (*Neolema abbreviata*)

- Releases only began in 2013, but there is no harm in checking release sites. The adults are mostly black with yellow wing cases, but like the other tradescantia beetles tend to drop when disturbed. 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 would not expect you to find enough beetles to be able to begin harvesting and redistribution just yet.

Woolly nightshade lace bug (*Gargaphia decoris*)

- Once the weather warms up look on the undersides of leaves at release sites for the adults and nymphs, especially

on leaves showing signs of bleaching or black spotting around the margins.

- We expect the lace bugs might also be slow to disperse, so if good numbers are present, it would be worth collecting some to release in other areas. As per the story in this newsletter on page 2 that there is now some evidence that the lace bugs do best in partial shade, it would be best to target sites where woolly nightshade is partially shaded, for any redistribution efforts. Always wear gloves when handling woolly nightshade foliage to avoid any health issues. Cut leaf material that is infested with adults and/or nymphs and wedge or tie this material firmly into new woolly nightshade plants so the lace bugs can move across. We recommend that you shift at least 1000 individuals to each new site at any time during the warmer months.

Other agents

You might also need to check or distribute the following this spring (for further details see <http://www.landcareresearch.co.nz/publications/books/biocontrol-of-weeds-book>):

- Broom psyllid (*Arytainilla spartiophila*)
- Broom seed beetle (*Bruchidius villosus*)
- Gorse soft shoot moth (*Agonopterix umbellana*)
- Gorse thrips (*Sericothrips staphylinus*)
- Gorse colonial hard shoot moth (*Pempelia genistella*)
- Ragwort crown-boring moth (*Cochylis atricapitana*)

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



Tradescantia stem beetle adult and feeding damage.

Who's Who in Biological Control of Weeds?

<p>Alligator weed beetle (<i>Agasicles hygrophila</i>)</p> <p>Alligator weed beetle (<i>Disonycha argentinensis</i>)</p> <p>Alligator weed moth (<i>Arcola malloi</i>)</p>	<p>Foliage feeder, common, often provides excellent control on static water bodies.</p> <p>Foliage feeder, released widely in the early 1980s, failed to establish.</p> <p>Stem borer, common in some areas, can provide excellent control on static water bodies.</p>
<p>Blackberry rust (<i>Phragmidium violaceum</i>)</p>	<p>Leaf rust fungus, self-introduced, common in areas where susceptible plants occur, can be damaging but many plants are resistant.</p>
<p>Boneseed leaf roller (<i>Tortrix</i> s.l. sp. "chrysanthemoides")</p>	<p>Foliage feeder, established and quite common at some NI sites but no significant damage yet. Appears to be limited by predation and parasitism.</p>
<p>Bridal creeper rust (<i>Puccinia myrsiphylli</i>)</p>	<p>Rust fungus, self-introduced, first noticed in 2005, widespread, causing severe damage at many sites.</p>
<p>Broom gall mite (<i>Aceria genistae</i>)</p> <p>Broom leaf beetle (<i>Gonioctena olivacea</i>)</p> <p>Broom psyllid (<i>Arytainilla spartiophila</i>)</p> <p>Broom seed beetle (<i>Bruchidius villosus</i>)</p> <p>Broom shoot moth (<i>Agonopterix assimilella</i>)</p> <p>Broom twig miner (<i>Leucoptera spartifoliella</i>)</p>	<p>Gall former, recently released widely, establishing well and already severely damaging plants at some sites.</p> <p>Foliage feeder, recently released widely, establishment appears likely at a few sites so far.</p> <p>Sap sucker, becoming common, some damaging outbreaks seen, but may be limited by predation, impact unknown.</p> <p>Seed feeder, common in many areas, now destroying up to 84% of seeds at older release sites.</p> <p>Foliage feeder, recently released at limited sites as difficult to rear, establishment appears likely at one site to date.</p> <p>Stem miner, self-introduced, common, often causes obvious damage.</p>
<p>Californian thistle flea beetle (<i>Altica carduorum</i>)</p> <p>Californian thistle gall fly (<i>Urophora cardui</i>)</p> <p>Californian thistle leaf beetle (<i>Lema cyanella</i>)</p> <p>Californian thistle rust (<i>Puccinia punctiformis</i>)</p> <p>Californian thistle stem miner (<i>Ceratopion onopordi</i>)</p> <p>Green thistle beetle (<i>Cassida rubiginosa</i>)</p>	<p>Foliage feeder, released widely during the early 1990s, failed to establish.</p> <p>Gall former, rare as galls tend to be eaten by sheep, impact unknown.</p> <p>Foliage feeder, only established at one site near Auckland where it causes obvious damage.</p> <p>Systemic rust fungus, self-introduced, common, damage usually not widespread.</p> <p>Stem miner, attacks a range of thistles, recently released at limited sites as difficult to rear, establishment success unknown.</p> <p>Foliage feeder, attacks a range of thistles, recently released widely, establishing well with obvious damage seen at some sites already.</p>
<p>Chilean needle grass rust (<i>Uromyces pencanus</i>)</p>	<p>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.</p>
<p>Darwin's barberry flower bud weevil (<i>Anthonomus kuscheli</i>)</p> <p>Darwin's barberry seed weevil (<i>Berberidicola exaratus</i>)</p>	<p>Flower bud feeder, approved for release in 2012, releases are likely to begin in 2015.</p> <p>Seed feeder, approved for release in 2012, releases are likely to begin this spring.</p>
<p>Gorse colonial hard shoot moth (<i>Pempelia genistella</i>)</p> <p>Gorse hard shoot moth (<i>Scythris grandipennis</i>)</p> <p>Gorse pod moth (<i>Cydia succedana</i>)</p> <p>Gorse seed weevil (<i>Exapion ulicis</i>)</p> <p>Gorse soft shoot moth (<i>Agonopterix umbellana</i>)</p> <p>Gorse spider mite (<i>Tetranychus lintearius</i>)</p> <p>Gorse stem miner (<i>Anisoplaça pytoptera</i>)</p> <p>Gorse thrips (<i>Sericothrips staphylinus</i>)</p>	<p>Foliage feeder, from limited releases established only in Canterbury, impact unknown, but obvious damage seen at several sites.</p> <p>Foliage feeder, failed to establish from small number released at one site, no further releases planned due to rearing difficulties.</p> <p>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.</p> <p>Seed feeder, common, destroys many seeds in spring.</p> <p>Foliage feeder, established poorly in the NI but well established and common in parts of the SI, some impressive outbreaks seen, impact unknown.</p> <p>Sap sucker, common, often causes obvious damage, but ability to persist is limited by predation.</p> <p>Stem miner, native, common in the SI, often causes obvious damage, lemon tree borer has similar impact in the NI.</p> <p>Sap sucker, common in many areas, impact unknown.</p>
<p>Heather beetle (<i>Lochmaea suturalis</i>)</p>	<p>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 will be released soon.</p>
<p>Hemlock moth (<i>Agonopterix alstromeriana</i>)</p>	<p>Foliage feeder, self-introduced, common, often causes severe damage.</p>

<p>Hieracium crown hover fly (<i>Cheilosia psilophthalma</i>)</p> <p>Hieracium gall midge (<i>Macrolabis pilosellae</i>)</p> <p>Hieracium gall wasp (<i>Aulacidea subterminalis</i>)</p> <p>Hieracium plume moth (<i>Oxyptilus pilosellae</i>)</p> <p>Hieracium root hover fly (<i>Cheilosia urbana</i>)</p> <p>Hieracium rust (<i>Puccinia hieracii</i> var. <i>piloselloidarum</i>)</p>	<p>Crown feeder, released at limited sites as difficult to rear, establishment success unknown.</p> <p>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.</p> <p>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.</p> <p>Foliage feeder, only released at one site due to rearing difficulties, did not establish.</p> <p>Root feeder, released at limited sites as difficult to rear, establishment success unknown.</p> <p>Leaf rust fungus, self-introduced?, common, causes slight damage to some mouse-ear hawkweed, plants vary in susceptibility.</p>
<p>Japanese honeysuckle white admiral (<i>Limenitis gloriifica</i>)</p>	<p>Foliage feeder, approved for release in 2013, unable to be reared in captivity but direct field releases are likely to begin this spring.</p>
<p>Lantana blister rust (<i>Puccinia lantanae</i>)</p> <p>Lantana leaf rust (<i>Prospodium tuberculatum</i>)</p> <p>Lantana plume moth (<i>Lantanophaga pusillidactyla</i>)</p>	<p>Rust fungus, approved for release in 2012, releases are likely to begin this spring, damages leaves and stems and can cause whole branches to die back.</p> <p>Rust fungus, approved for release in 2012, releases are likely to begin this spring, causes leaf death and defoliation.</p> <p>Flower feeder, self-introduced, host-range, distribution and impact unknown.</p>
<p>Mexican devil weed gall fly (<i>Procecidochares utilis</i>)</p> <p>Mexican devil weed leaf fungus (<i>Passalora ageratinae</i>)</p>	<p>Gall former, common, initially high impact but now reduced considerably by Australian parasitic wasp.</p> <p>Leaf fungus, probably accidentally introduced with gall fly in 1958, common and almost certainly having an impact.</p>
<p>Mist flower fungus (<i>Entyloma ageratinae</i>)</p> <p>Mist flower gall fly (<i>Procecidochares alanī</i>)</p>	<p>Leaf smut, common and often causes severe damage.</p> <p>Gall former, common now at many sites, in conjunction with the leaf smut provides excellent control of mist flower.</p>
<p>Moth plant beetle (<i>Colaspis argentinensis</i>)</p>	<p>Root feeder, approved for release in 2011 but no releases made yet as waiting for export permit to be granted by Argentinean authorities.</p>
<p>Nodding thistle crown weevil (<i>Trichosirocalus horridus</i>)</p> <p>Nodding thistle gall fly (<i>Urophora solstitialis</i>)</p> <p>Nodding thistle receptacle weevil (<i>Rhinocyllus conicus</i>)</p>	<p>Root and crown feeder, becoming common on several thistles, often provides excellent control in conjunction with other thistle agents.</p> <p>Seed feeder, becoming common, can help to provide control in conjunction with other thistle agents.</p> <p>Seed feeder, common on several thistles, can help to provide control of nodding thistle in conjunction with other thistle agents.</p>
<p>Old man's beard leaf fungus (<i>Phoma clematidina</i>)</p> <p>Old man's beard leaf miner (<i>Phytomyza vitalbae</i>)</p> <p>Old man's beard sawfly (<i>Monophadnus spinolae</i>)</p>	<p>Leaf fungus, initially caused noticeable damage but has become rare or died out.</p> <p>Leaf miner, common, damaging outbreaks occasionally seen, but appears to be limited by parasitism.</p> <p>Foliage feeder, released at limited sites as difficult to rear, probably failed to establish.</p>
<p>Cinnabar moth (<i>Tyria jacobaeae</i>)</p> <p>Ragwort crown-boring moth (<i>Cochylis atricapitana</i>)</p> <p>Ragwort flea beetle (<i>Longitarsus jacobaeae</i>)</p> <p>Ragwort plume moth (<i>Platyptilia isodactyla</i>)</p> <p>Ragwort seed fly (<i>Botanophila jacobaeae</i>)</p>	<p>Foliage feeder, common in some areas, often causes obvious damage.</p> <p>Stem miner and crown borer, released widely, has probably failed to establish.</p> <p>Root and crown feeder, common, provides excellent control in many areas.</p> <p>Stem, crown and root borer, recently released widely, well established and quickly reducing ragwort noticeably at many sites.</p> <p>Seed feeder, established in the central NI, no significant impact.</p>
<p>Greater St John's wort beetle (<i>Chrysolina quadrigemina</i>)</p> <p>Lesser St John's wort beetle (<i>Chrysolina hyperici</i>)</p> <p>St John's wort gall midge (<i>Zeuxidiplosis giardi</i>)</p>	<p>Foliage feeder, common in some areas, not believed to be as significant as the lesser St John's wort beetle.</p> <p>Foliage feeder, common, nearly always provides excellent control.</p> <p>Gall former, established in the northern SI, often causes severe stunting.</p>
<p>Scotch thistle gall fly (<i>Urophora stylata</i>)</p>	<p>Seed feeder, released at limited sites, establishing and spreading readily, fewer thistles observed at some sites, impact unknown.</p>
<p>Tradescantia leaf beetle (<i>Neolema ogloblini</i>)</p> <p>Tradescantia stem beetle (<i>Lema basicostata</i>)</p> <p>Tradescantia tip beetle (<i>Neolema abbreviata</i>)</p> <p>Tradescantia yellow leaf spot (<i>Kordyana</i> sp.)</p>	<p>Foliage feeder, released widely since 2011, appears to be establishing well at many sites.</p> <p>Stem borer, releases began in 2012 and are continuing, already well-established and numbers appear to be building rapidly.</p> <p>Tip feeder, releases began in 2013 and are continuing, appears to be establishing readily.</p> <p>Leaf fungus, approved for released in 2013, releases are likely to begin in 2015.</p>
<p>Woolly nightshade lace bug (<i>Gargaphia decoris</i>)</p>	<p>Sap sucker, recently released widely, establishing readily at many sites, some severe damage seen this year at a shady site in the Bay of Plenty.</p>



Biocontrol Agents Released in 2013/14

Species	Releases made
Broom leaf beetle (<i>Gonioctena olivacea</i>)	6
Broom gall mite (<i>Aceria genistae</i>)	110
Tradescantia leaf beetle (<i>Neolema ogloblini</i>)	2
Tradescantia stem beetle (<i>Lema basicostata</i>)	4
Tradescantia tip beetle (<i>Neolema abbreviata</i>)	4
Woolly nightshade lace bug (<i>Gargaphia decoris</i>)	3
Total	129



Andrew Blayney

Woolly nightshade lace bug adults overwintering in dead and dying leaves.

Further Reading

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ISSN 1173-762X (Print) ISSN 1177-8784 (Online)



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