

Weed Biocontrol

WHAT'S NEW?

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Manaaki Whenua
Landcare Research



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COVER IMAGE: Pampas flowerhead infected with black floral smut.
Credit: Hernan Norambuena.



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Solving Pampas Puzzles

The work to determine if there are suitable biocontrol agents for pampas continues to encounter some intriguing challenges, but the picture is gradually becoming a little clearer.

Pampas can be found throughout New Zealand but is mainly problematic in the northern regions. There are two main weedy species, *Cortaderia selloana* and *C. jubata*, both originating from South America. Molecular studies have also detected at least one other South American *Cortaderia* entity, which is much less common. This could become a weed in the future, so ideally a biocontrol programme would find agents to control it too. Two plant-hoppers (*Saccharosydne subandina* and *Lacertinella australis*), which attack the foliage, have been identified as the most promising insect agents for pampas. While similar in appearance, the two species can be distinguished with the aid of a hand lens or microscope. Both have proven difficult to work with, as they are very fragile and easily damaged by handling and shipping. However, perseverance and hand-carrying of carefully packed shipments eventually paid off when a colony of *S. subandina* was recently successfully established in containment in Auckland.

The host range of both plant-hoppers was described in the literature as *Cortaderia*, rye [*Secale cereale*] and garlic [*Allium sativum*]. "However, this struck us as odd since these species are not closely related, and when we tested the pampas plant-hoppers on rye and garlic early on we quickly determined they weren't hosts," said Quentin Paynter. This made the team working on the project suspicious that cryptic species might be involved, whereby the plant-hoppers look identical and differences between them can only be determined by examining their DNA. This means that what is reported to be a species with a wide host range can turn out to be a complex of entities with narrower host ranges.

"We then studied the DNA of the pampas plant-hoppers we had collected from a range of sites in Chile, which showed at least three cryptic species within *S. subandina* and two within *L. australis*," said Quentin. This opened up the possibility that pampas plant-hoppers might have different host ranges within *Cortaderia*. It might also explain why it was such a struggle to successfully establish colonies of some of the imported material. They were possibly being offered a sub-optimal host, which they could feed on if offered no alternative but that would not allow them to produce healthy offspring, leading to colony failure after a couple of months.

The team are studying plant-hoppers from Chile first, because it is currently too difficult to get permission to export them from other South American countries. *Cortaderia jubata* is not present in Chile, and New Zealand material has come from Peru or Ecuador. Despite searching widely throughout South America, only a handful of *C. selloana* plants have been found that match the New Zealand material, all deliberately planted as ornamentals in Chile. As a result, most of the plant-hoppers have been collected from *Cortaderia* species that don't occur in New Zealand. The plant-hopper now well established in containment is – not surprisingly – *S. subandina*, collected off *C. selloana*, which is known to be a good match. *Lacertinella australis* has only been found at higher altitudes in Chile on *Cortaderia* species probably not present in New Zealand, and it has failed to thrive in containment on material available in New Zealand. This would seem to rule out this plant-hopper as a contender unless further surveys in Chile can find more, preferably wild-growing, *C. selloana* populations with *L. australis* on them.

Once molecular studies confirmed that we were dealing with cryptic species, individual females were reared in isolated lines to create populations of known

identity. Once the female had produced offspring, a molecular test was used to determine the entity she belonged to, and then like progeny could be combined with like. “Working with cryptic species is tricky, time consuming and expensive!” said Quentin. At this point, since only one entity was doing well, the other lines were culled to avoid any possible contamination, and the team were finally able to begin proper host-range testing.

What happened next was quite unexpected. The plant-hoppers showed no signs of attacking native toetoe (*Austroderia* spp.), which was hugely promising, apart from one *A. fulvida* plant. The other five replicates of this species were unharmed. The attacked plant died soon after and was possibly unusually susceptible to plant-hopper attack because it was already compromised in some way. The team checked and ruled out that the result could be explained by misidentification, so more testing is required to explore this unusual result, to see, for example, whether toetoe plants are less well defended against herbivores when young. Testing has shown that this plant-hopper entity does not do that well on *C. jubata*, meaning that further studies of the plant-hoppers found on this host in Ecuador might need to be carried out in the future.

Since other similar species of plant-hoppers are associated with species of phytoplasma (specialised bacteria that cause plant disease), the phytoplasma status of the pampas plant-hoppers has been explored using molecular tools. The first shipment ever received from Chile returned a positive result: it was a 99% match for a bunch of phytoplasmas that relate to *Candidatus Phytoplasma australiense*, the organism responsible for disease in cabbage trees and flax, previously thought to occur only in New Zealand and Australia. Other shipments of the plant-hoppers have tested negative, including the current populations being studied in containment. However, further work is needed to explore the risk that pampas plant-hoppers could vector phytoplasma already in New Zealand. In New Zealand, *Candidatus Phytoplasma australiense* is spread by a native plant-hopper (*Zeoliarus oppositus*), which occasionally frequents pampas, so it may have spread the disease to pampas already, where it may remain uncommon without a suitable vector. “We are running some trials where we cage the native plant-hopper onto pampas plants to allow phytoplasma infection to occur. Next we put the pampas plant-hoppers onto these plants for a time and then move them to clean plants to see if they can successfully transmit the disease,” said Quentin. The results should be in later this year. There are still many unknowns, but if the pampas plant-hoppers are highly host-specific and can vector phytoplasma already present in pampas in New Zealand, this could prove to be a highly damaging combination.



Pampas plant-hopper, likely *Saccharosydne subandina*.

Meanwhile, work to discover the secrets of a black smut fungus [*Ustilago quitensis*] has also been continuing. This fungus attacks the flowerheads and could potentially reduce the ability of pampas plants to produce seed, but the infection process is poorly understood. Chantal Probst has been working with fungal material, also from Chile, trying a range of inoculation techniques. This work is complicated by the length of time that can elapse between infection and the emergence of infected floral plumes (months or even years later), and the logistics of growing on and then housing large flowering-age plants in a containment facility, let alone getting them to flower on demand.

This has created the need to find alternative study methods. On artificial media the smut becomes a yeast, which needs to mate with another yeast form, with different mating type genes, to be able to infect plants. Attempts to do this were unsuccessful. Next mini pampas plants were grown in test tubes and pots and attempts made to infect them in various ways. “Recently I made a key breakthrough using this approach by injecting a teliospore suspension into the plants,” said Chantal. “I was able to successfully detect the smut in the tissue of these plants using molecular techniques a few months later.” The next step is to bring plants starting to produce flowers into containment and inject the teliospores in the forming inflorescence to see if the smut develops on the flowerheads. Once a reliable inoculation method has been developed, host range testing can begin.

There is still much to learn about the black smut, phytoplasma and plant-hoppers, and work to be done, but the team hasn’t yet ruled out the possibility of biocontrol for this tricky target in the future.

This project was originally funded by a grant from the Sustainable Farming Fund and more recently by the National Biocontrol Collective. Manaaki Whenua – Landcare Research is using some of its discretionary funding provided by the Ministry for Innovation, Business and Employment to support the black floral smut and phytoplasma studies. We acknowledge the assistance of our Chilean collaborator, Dr Hernan Norambuena, in providing shipments of organisms for study.

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Preventing Lesser Calamint from Becoming a Greater Problem

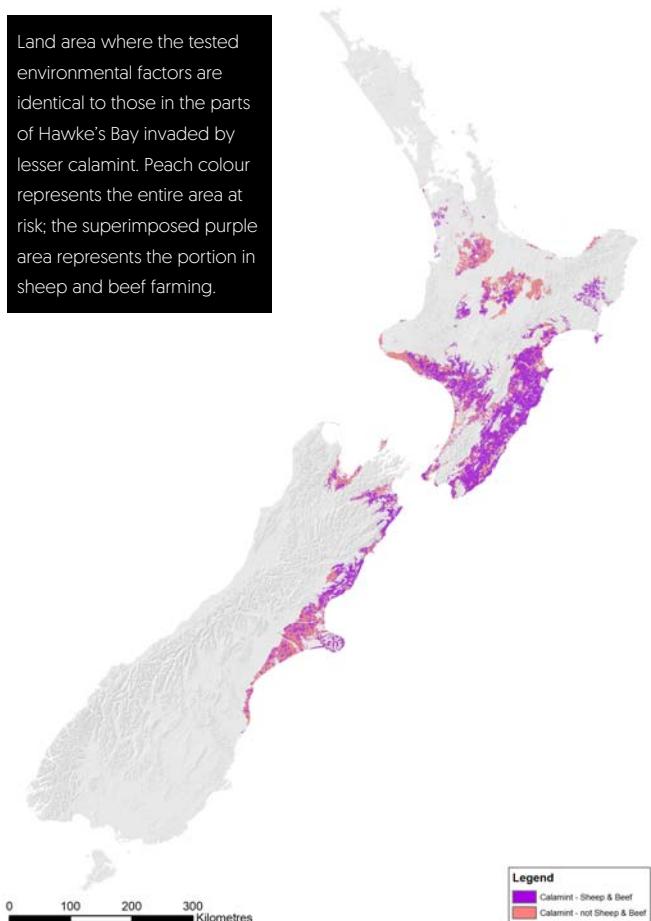
A Sustainable Farming Fund grant is providing the opportunity for a new biocontrol project to get underway for lesser calamint (*Calamintha nepeta*), an emerging weed on the east coast of the North Island. "Lesser calamint is particularly bad on sheep and beef farms in Hawke's Bay, where it displaces desirable pasture species," said Ronny Groenteman, who previously reviewed the feasibility of biocontrol for this target (see Issue 73). This herb, which is unpalatable to stock and difficult and costly to control, seems poised to pose a serious threat to farming and conservation. Lesser calamint grows especially well in disturbed areas with low rainfall and copes well with drought conditions. "Lesser calamint is already having a serious economic impact in Hawke's Bay, where it has established on more than 100 farms," said Darin Underhill of the Hawke's Bay Regional Council.

A recurring issue when considering the merits of developing biocontrol for new, emerging weeds and securing funding for the work is trying to predict future geographical spread and impacts. We need ways to predict how likely they are to end up as a serious problem and where. To determine which parts of New Zealand are most at risk of invasion from newly emerging weeds we rely on projections from distribution models. "In the past we have asked Grant Humphries (Black Bawks Data Science Ltd) to run a random forests algorithm to predict regions that might be vulnerable to invasion. Due to a mismatch in geographical information systems (GIS) layer resolution, this model has to ignore rainfall, which can be an important environmental factor, especially for lesser calamint," explained Ronny. The random forests algorithm is also quite time consuming and therefore expensive. "Recently we have looked at alternative modelling approaches available, and compared them to see how consistent their predictions are," said Ronny.

The CLIMEX model used by colleagues at Plant & Food Research, as well as the Environmental Envelope that uses GIS layers, run by James Barringer (Manaki Whenua – Landcare Research), were compared with results from the random forests model. "We were not so much interested in the maximum land area that could be invaded but rather a more conservative prediction of the areas with the highest risk of invasion," said Ronny. The most reliable and cost effective method for predicting lesser calamint invasion was the Environmental Envelope system (see map).

The results clearly show that intervention against this weed is clearly warranted, with at least 218,918 hectares of land highly suitable for lesser calamint, of which 133,212 hectares are currently in sheep and beef land use. "Assuming a biologically realistic spread rate, and that up to 50% of available forage could be lost due to lesser calamint, we have estimated that the weed could cost New Zealand sheep and beef farmers annually up to \$1.5 million by 2030, over \$15 million by 2040,

Land area where the tested environmental factors are identical to those in the parts of Hawke's Bay invaded by lesser calamint. Peach colour represents the entire area at risk; the superimposed purple area represents the portion in sheep and beef farming.



and \$100 million by 2050," said Paul Peterson, who is working with the Hawke's Bay Lesser Calamint Control Group on the new biocontrol project. The focus of the project will be to find potential biocontrol agents in Europe suitable for New Zealand. Surveys will be undertaken here and in Europe to inform the best choice and source of agents, and efforts will be made to build public awareness about this plant.

"In the past, biocontrol has traditionally been a last resort, when other options have failed, so it is great to see funders and communities willing to be proactive by supporting projects much earlier on," said Paul. Hopefully, this new project will mean that predictions that lesser calamint could occupy significantly greater areas of New Zealand will never be realised.

This project to predict the possible distribution of lesser calamint was funded by the Ministry of Business, Innovation, and Employment as part of Manaaki Whenua – Landcare Research's Beating Weeds programme. The Sustainable Farming Fund is administered by the Ministry for Primary Industries. The Hawke's Bay Lesser Calamint Control Group is composed mostly of farmers keen to seek solutions to the lesser calamint problem.

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New Project for Vanuatu

Vanuatu is a beautiful, mountainous archipelago of volcanic origin in the South Pacific. Consisting of over 80 islands, and with a total land area of 12,200 km², Vanuatu has a tropical climate moderated by southeast trade winds, and a population of just under 274,000. As a developing country Vanuatu faces its share of challenges, including top ranking in the world for natural disaster risk. Natural hazards include tropical cyclones from January to April, volcanic activity, earthquakes, tsunamis, flooding and drought. In 2015 Vanuatu suffered widespread devastation from Severe Tropical Cyclone Pam, one of the worst-ever cyclones to hit the region, and in 2017 volcanic activity required the residents of one island [Ambae] to be evacuated for several months. The economy relies on tourism and natural resources, including hardwood forests and fish, plus exporting produce, particularly kava, copra and beef.

Like most Pacific islands, Vanuatu has its share of undesirable invasive weeds, which have an impact on agricultural and horticultural activities, threaten biodiversity, and create human and animal health issues. Vanuatu also has aquatic weeds that reduce access to water bodies and increase the risk of mosquito-borne viruses, such as dengue fever, by reducing water quality and flow. Since weeds thrive on disturbance, they are often the first species to regrow following natural disasters such as cyclones. Climate change is therefore expected to further exacerbate weed issues in the region.

Most weeds are currently managed by slashing or mowing, since herbicides are expensive or not readily available. Fire is also sometimes used as a control tool, but it is not always an option, such as where grazing lands are also used for plantation crops like coconuts. Controlling weeds manually is time-consuming and the benefits are often short-lived, since in a tropical climate weeds regrow rapidly. More sustainable and cost-effective weed management options are needed.

Biocontrol is the only feasible, long-term, safe control option for most weeds once they are widespread, especially in developing countries, which have fewer resources available for pest management. Vanuatu has long embraced the use of biological control for weeds, releasing the first agent, a lacebug (*Teleonemia scrupulosa*), against lantana [*Lantana camara*] in 1935 (see table). Since then nine biological control agents have been introduced against eight weed species. “Seven of these agents have established, plus another six have arrived without assistance,” said Michael Day, of Biosecurity Queensland, who has helped to release a number of biocontrol agents in Vanuatu recently.

The most successful agent is a beetle [*Calligrapha pantherina*], which now provides complete control of broom weed [*Sida acuta* and *Sida rhombifolia*]. Control of water hyacinth [*Eichhornia crassipes*] by two weevils [*Neochetina bruchi* and

Credit: CSIRO



The highly effective broom weed beetle

N. eichhorniae], and water lettuce [*Pistia stratiotes*] by a third weevil [*Neohydronomus affinis*], has also been fairly good in most areas. Anecdotal evidence suggests that a rust [*Puccinia spegazzinii*] is having an impact on mile-a-minute [*Mikania micrantha*], and a moth [*Epiblema strenuana*] has also reduced the threat posed by parthenium [*Parthenium hysterophorus*]. However, there is considerable potential to build on these good foundations, and an ambitious new 5-year project, which began in July 2018, is aiming to do just that.

The latest project is funded by New Zealand’s Ministry of Foreign Affairs and Trade [MFAT] and is focused on key pasture weeds affecting the beef industry. Vanuatu is the largest producer of beef in the South Pacific, but a recent study found that cattle numbers and carcass weights have fallen since 2007. Pasture quality is thought to be a contributing factor, as about 90% of beef farmers report having a problem with unpalatable/poisonous weeds out-competing more desirable pasture species. If key pasture weeds can be better managed through biocontrol, it could benefit beef farmers – and their communities – in many ways. They would have more time and money to put into other farming activities and bring more land into production. The harmful effects of unregulated herbicide use would also be reduced, especially since protective clothing and training for herbicide applicators is not often readily available.

Manaaki Whenua – Landcare Research, in collaboration with Michael Day, will work closely with Biosecurity Vanuatu on the new project. A team of five people at Biosecurity Vanuatu [Leisongi Bulesulu, Bill Garae, Jeffline Tasale, Lee Howard and Joseph Novwai] will be trained to manage the weed biocontrol programmes. Sadly, former local weed biocontrol expert Sylverio Bule passed away last year. “We are excited about working with the new team in Vanuatu and the prospect of building biocontrol expertise in the Pacific,” said project leader Lynley Hayes. “Biosecurity Vanuatu is excited to be helping cattle farmers get rid of weeds in an environmentally friendly way so they can produce quality

beef for local consumption and the export market. Ni-vans and other people love Vanuatu beef!" said Leisongi Bulesulu.

The three worst weeds affecting pastures on the five islands most important for beef production [Efate, Epi, Malekula, Tanna and Espiritu Santo] are pico/turkey berry [*Solanum torvum*], hibiscus burr [*Urena lobata*] and wild peanut [*Senna tora*]. No biocontrol programmes have been developed anywhere for these weeds, which can all grow to more than a metre in height. Turkey berry is a shrub that can form prickly impenetrable thickets and is readily dispersed by birds feeding on the berries. Hibiscus burr is widely grown throughout the tropics as a fibre crop, as it makes a good substitute for jute. As the name suggests, this weed has sticky burrs, which facilitate dispersal. Wild peanut dies off during the dry season but produces abundant seeds, which are readily spread by livestock. These seeds rapidly germinate once the rains return. Since all three species potentially have beneficial/medicinal uses, any potential conflicts of interest arising from biocontrol will need to be carefully evaluated.

Little is known about the natural enemies of the three novel targets, and surveys in the native range will be undertaken to determine the available options. Molecular studies are being undertaken to try to determine the origins of the Vanuatu weed populations. Since the reported native range

for two of the species is vast, studies will try to pinpoint the best places to survey for potential agents. Turkey berry is reported to be native to the American tropics/subtropics, from Florida to Brazil, and hibiscus burr is reportedly native to somewhere in Asia, possibly China. Reports suggest that wild peanut is native to Belize and El Salvador, but this may be an underestimate.

An Australian project has previously looked for biocontrol agents for a very closely related, almost identical, species to wild peanut, known as sicklepod [*S. obtusifolia*]. Sicklepod is native to South America and is problematic in Queensland. Surveys in Honduras and Mexico turned up a number of potential biocontrol agents, but the project ended before any agents could be released. Fortunately, unlike Australia, Vanuatu does not have 50 native *Senna* species to contend with. Some of the natural enemies of sicklepod, including four beetles and three moths, may well be sufficiently specific for Vanuatu, and appear worthy of further study as "new association agents", in addition to any promising species found on wild peanut itself.

Other leads that will be explored for the remaining new targets include a beetle [*Leptinotarsa undecimlineata*], which is a close relative of a serious potato pest, the Colorado potato beetle [*Leptinotarsa decimlineata*], and is reported

Weed Biocontrol Agents in Vanuatu

Weed	Agent	Released	Impact
Broadleaved tobacco weed <i>Elephantopus mollis</i>	Fly <i>Tetraeuaresta obscuriventris</i>	No, reported 1984	Unknown but plant now seems rare
Broom weed <i>Sida</i> spp.	Beetle <i>Calligrapha pantherina</i>	Yes, 2005	High
Lantana <i>Lantana camara</i>	Lacebug <i>Teleonemia scrupulosa</i>	Yes, 1935	Slight
	Beetle <i>Uroplata girardi</i>	Yes, 1983	Slight
	Fly <i>Calycomyza lantanae</i>	No, reported 2012	Slight
	Fly <i>Ophiomyia lantanae</i>	As above	Slight
	Moth <i>Crocidosema lantana</i>	As above	Slight
	Moth <i>Hypena laceratalis</i>	As above	Slight
Mile-a-minute <i>Mikania micrantha</i>	Rust <i>Puccinia spegazzinii</i>	Yes, 2012	Unknown but seems variable, from minor to high
Parthenium <i>Parthenium hysterophorus</i>	Moth <i>Epiblema strenuana</i>	No, reported 2014	High
Water hyacinth <i>Eichhornia crassipes</i>	Weevil <i>Neochetina eichhorniae</i> <i>Neochetina bruchi</i>	Yes 2004 2013	High Unknown
Water lettuce <i>Pistia stratiotes</i>	Weevil <i>Neohydronomus affinis</i>	Yes, 2006	Variable



Pasture on Efate heavily infested with hibiscus burr, with some turkey berry in the background

to attack turkey berry in Cuba, Honduras and Mexico. "Some no-choice testing of this beetle showed no, or at best poor, larval survival on potato, suggesting it could well be sufficiently host specific as an agent for turkey berry," explained Quentin Paynter, who will be heavily involved in the search for new agents. Hibiscus burr is reported to be damaged by a number of pathogens in its introduced range, including one (*Macrophoma ureniae*) that severely affected the plant when grown as a crop in Africa. The potential of these pathogens will be investigated further.

Further work is also needed to improve control of other key pasture weeds, such as nail grass / giant sensitive plant (*Mimosa diplostachya*), lantana and parthenium. It is uncertain whether a psyllid (*Heteropsylla spinulosa*) released previously against giant sensitive plant has established, and it will be reintroduced from Australia if surveys don't find it in Vanuatu. Another agent previously released there, but not thought to have established, is a beetle (*Zygogramma bicolorata*) for parthenium. "The beetle was released in only small numbers, so it will be reimported from Australia and released this time in much bigger numbers," said Michael. Lantana agents, also readily available in Australia, such as a budmite (*Aceria lantanae*) and/or the herring-bone fly (*Ophiomyia camarae*), will be introduced to Vanuatu too. So that the Biosecurity Vanuatu team can gain experience in working with a wide range of biocontrol agents, a lacebug (*Carvalhotingis visenda*) for the environmental weed cat's claw creeper (*Dolichandra unguis-cati*) will also be introduced from Australia, and a gall mite (*Colomerus spathodeae*) for African tulip tree (*Spathodea campanulata*) from Rarotonga.

Lessons learnt from previous projects in Vanuatu and other Pacific countries are being incorporated into the new project. These include the need to build a team of experts and a wide support base for biocontrol activities, and to plan for the damage tropical cyclones can do to infrastructure and release sites. Also, there is a need to closely monitor the impact of new agents, since successful ones can work

quickly in the tropics, taking years rather than decades to knock back their targets. "Although this project is initially aimed at improving the productivity of medium to large beef enterprises in Vanuatu, our hope is that it will ultimately benefit smaller enterprises, the wider pastoral sector, the environment, and other Pacific nations with similar weed problems," said Lynley.

We welcome any advice, information or suggestions from our international colleagues about the best places to survey for biocontrol agents for turkey berry, wild peanut and hibiscus burr, and any additional information known about their natural enemies.

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Changes to Pages

If you are keeping your copy of The Biological Control of Weeds Book up to date you might like to download the following new or amended pages from www.landcareresearch.co.nz/publications/books/biocontrol-of-weeds-book

Information Sheets

- Contacts
- Index
- Giant Reed Gall Wasp
- Tradescantia
- Tradescantia Yellow Leaf Spot Fungus

Monitoring Forms

- Giant Reed Gall Wasp
- Japanese Honeysuckle Stem Beetle
- Privet Lace bug
- Tradescantia Yellow Leaf Spot Fungus

Spring Activities

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

Broom leaf beetles (*Gonioctena olivacea*)

- Look for beetles by beating plants over a tray. The adults 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, which may also be seen feeding on leaves and shoot tips.
- The beetles can be harvested if you find them in good numbers. Aim to shift at least 100 beetles to sites that are not yet infested with gall mites.

Broom shoot moth (*Agonopterix assimilella*)

- Late spring is the best time to check release sites, so 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 are unsure if this moth has managed to successfully establish in New Zealand, 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.

Darwin's barberry weevil (*Berberidicola exaratus*)

- Although it is early days for checking release sites, later in the spring it might be worth beating some plants to see if any of the small (3–4 mm long), blackish adults can be found. Also examine the fruits for signs of puncturing.
- Since establishment is not yet confirmed, it will be too soon to consider harvesting and redistribution if you do find the weevils.

Giant reed gall wasp

- Again, although it is early days it might be worth checking release sites this spring to look for swellings on the stems caused by the gall wasps. These look like small corn cobs on large vigorous stems, or like broadened deformed shoot tips when side shoots are attacked.
- It will be too soon to consider harvesting and redistribution if you do see evidence of the gall wasp establishing.

Japanese honeysuckle white admiral

- Look for the adult butterflies at release sites from late spring. Look also for pale yellow eggs laid singly on the upper and lower surfaces of the leaves, and for the caterpillars. When small, the caterpillars are brown and found at the tips of leaves, where they construct pontoon-like extensions to the mid-rib. As they grow, the caterpillars turn green with spiky, brown, horn-like protrusions.
- Unless you find lots of caterpillars, don't consider harvesting and redistribution activities.



Early signs of tradescantia yellow leaf spot infections in the field.

Lantana blister rust (*Puccinia lantanae*)

- Check sites where lantana plants infected with blister rust have been planted out, 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. Stunting, defoliation and die-back may also be apparent.
- Once established, this rust is likely to be readily dispersed by the wind. If redistribution is needed, this will require 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 (MPI) will be required.

Lantana leaf rust (*Prospodium tuberculatum*)

- Check sites where the leaf rust has been released, 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. If the rust is well established, then extensive defoliation may be obvious.
- Once established, this rust is likely to be readily dispersed by the wind. If redistribution efforts are needed, the best method is to harvest infected leaves, wash them in water to make a spore solution, and then apply this to plants.

Privet lace bug (*Leptoypha hospita*)

- Although it is early days for privet lace bug, signs of their presence seem to be obvious quite soon following releases so it would definitely be worth checking the older release sites to confirm establishment. Examine the undersides of leaves for the adults and nymphs, especially leaves showing signs of bleaching.
- If large numbers are found, cut infested leaf material and put it in chilly bin or large paper rubbish bag, and tie or wedge this material into Chinese privet at new sites. Aim to shift at least 1,000 individuals to each new site.

Ragwort plume moth (*Platyptilia isodactyla*)

- October is the best time to check release sites for caterpillars, so look for plants with wilted, 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 coloration.

- 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 that any caterpillars can crawl across.

Tradescantia leaf beetle (*Neolema ogloblini*)

- Look for the shiny metallic bronze adults, or the larvae, which have a distinctive protective covering over their backs. Also 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.
- If you find them in good numbers, aim to collect and shift 50–100 beetles using a suction device or a small net.

Tradescantia stem beetle (*Lema basicostata*)

- The black knobbly adults can be difficult to see, so look for their feeding damage, which consists of elongated windows in the upper surfaces of leaves, or sometimes whole leaves consumed. Also look for stems showing signs of larval attack: brown, shrivelled or dead-looking.
- If you can find widespread damage you can begin harvesting. If it proves too difficult to collect 50–100 adults with a suction device, 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 [but make sure you have an exemption from MPI that allows you to do this].

Tradescantia tip beetle (*Neolema abbreviata*)

- Look for the adults, which are mostly black with yellow wing cases, and their feeding damage, which, like stem beetle damage, consists of elongated windows in the leaves. Larvae will be difficult to see inside the tips, but brown frass may be visible. When tips are in short supply, the slug-like larvae feed externally on the leaves.
- If you find them in good numbers, aim to collect and shift 50–100 beetles using a suction device or a small net.

Tradescantia yellow leaf spot (*Kordyana brasiliense*)

- Although the fungus was only released this past autumn, promising signs of likely establishment seen only a few months afterwards make it worth checking release sites this spring. Look for the distinctive yellow spots on the upper surface of the leaves with corresponding white spots underneath, especially after wet humid weather. Feel free to take a photo to send to us for confirmation if you are unsure, as occasionally other pathogens do damage tradescantia leaves.



Small Japanese honeysuckle white admiral caterpillar resting on its pontoon.

- The fungus is likely to disperse readily via spores on air currents. If human-assisted distribution is needed in the future, again it will be necessary to get permission to propagate and transport tradescantia plants from MPI. These plants can then be put out at sites where the fungus is present until they show signs of infection, and then planted out at new sites.

Other agents

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

- boneseed leafroller (*Tortrix* s.l. sp. "chrysanthemoides")
- broom gall mites (*Aceria genistae*)
- gorse soft shoot moth (*Agonopterix ulicetella*)
- gorse thrips (*Sericothrips staphylinus*)
- gorse colonial hard shoot moth (*Pempelia genistella*)
- green thistle beetle (*Cassida rubiginosa*)
- tradescantia leaf beetle (*Neolema ogloblini*)
- tradescantia stem beetle (*Lema basicostata*)
- tradescantia tip beetle (*Neolema abbreviata*).

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 Oct–Nov Sept–Oct Aug–Sept	Leaf beetle (<i>Gonioctena olivacea</i>) Psyllid (<i>Arytainilla spartiophila</i>) Shoot moth (<i>Agonopterix assimilella</i>) Twig miner (<i>Leucoptera spartifoliella</i>)
Lantana	Oct–Nov [or March–May]	Blister rust (<i>Puccinia lantanae</i>) Leaf rust (<i>Prospodium tuberculatum</i>)
Tradescantia	Nov–April Anytime	Leaf beetle (<i>Neolema ogloblini</i>) Stem beetle (<i>Lema basicostata</i>) Tip beetle (<i>Neolema abbreviata</i>) Yellow leaf spot fungus (<i>Kordyana brasiliense</i>)

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Who's Who in Biological Control of Weeds?

Alligator weed beetle [<i>Agasicles hygrophila</i>]	Foliage feeder, common, often provides excellent control on static water bodies.
Alligator weed beetle [<i>Disonycha argentinensis</i>]	Foliage feeder, released widely in the early 1980s, failed to establish.
Alligator weed moth [<i>Arcola malloii</i>]	Stem borer, common in some areas, can provide excellent control on static water bodies.
Blackberry rust [<i>Phragmidium violaceum</i>]	Leaf rust fungus, self-introduced, common in areas where susceptible plants occur, can be damaging but many plants are resistant.
Boneseed leaf roller [<i>Tortrix s.l. sp. "chrysanthemoides"</i>]	Foliage feeder, established and quite common at some North Island [NI] sites but no significant damage yet, limited by predation and parasitism.
Bridal creeper rust [<i>Puccinia myrsiphylli</i>]	Rust fungus, self-introduced, first noticed in 2005, widespread and providing good control.
Broom gall mite [<i>Aceria genistae</i>]	Gall former, establishing well and becoming widespread in some regions, and showing considerable promise by beginning to cause extensive damage to broom at many sites.
Broom leaf beetle [<i>Gonioctena olivacea</i>]	Foliage feeder, recently released widely, establishment confirmed at sites in both islands and numbers appear to be building, impact unknown.
Broom psyllid [<i>Arytainilla spartiophila</i>]	Sap sucker, becoming common, some damaging outbreaks seen, but may be limited by predation, impact unknown.
Broom seed beetle [<i>Bruchidius villosus</i>]	Seed feeder, common in many areas, now destroying up to 84% of seeds at older release sites.
Broom shoot moth [<i>Agonopterix assimilella</i>]	Foliage feeder, recently released at limited sites as difficult to rear, appears to be established in low numbers at perhaps 3 sites.
Broom twig miner [<i>Leucoptera spartifoliella</i>]	Stem miner, self-introduced, common, often causes obvious damage.
Californian thistle flea beetle [<i>Altica carduorum</i>]	Foliage feeder, released widely during the early 1990s, failed to establish.
Californian thistle gall fly [<i>Urophora cardui</i>]	Gall former, extremely rare as galls tend to be eaten by sheep, impact unknown.
Californian thistle leaf beetle [<i>Lema cyanella</i>]	Foliage feeder, only established at one site near Auckland where it causes obvious damage and from which it is dispersing.
Californian thistle rust [<i>Puccinia punctiformis</i>]	Systemic rust fungus, self-introduced, common, damage usually not widespread.
Californian thistle stem miner [<i>Ceratapion onopordi</i>]	Stem miner, attacks a range of thistles, recently released at limited sites as difficult to rear, establishment success unknown.
Green thistle beetle [<i>Cassida rubiginosa</i>]	Foliage feeder, attacks a range of thistles, released widely and establishing well with some damaging outbreaks beginning to occur.
Chilean needle grass rust [<i>Uromyces pencycanus</i>]	Rust fungus, approved for release in 2011 but no releases made yet as waiting for export permit to be granted, only South Island [SI] populations likely to be susceptible.
Darwin's barberry flower bud weevil [<i>Anthonomus kuscheli</i>]	Flower bud feeder, approved for release in 2012, releases will be made after the seed weevil is established if still needed.
Darwin's barberry seed weevil [<i>Berberidicola exaratus</i>]	Seed feeder, releases began in 2015, difficult to rear so widespread releases will begin once harvesting from field is possible, establishment looking likely at a Southland site.
Field horsetail weevil [<i>Grypus equiseti</i>]	Foliage and rhizome feeder, field releases began in 2017, establishment success unknown, further releases planned.
Giant reed gall wasp [<i>Tetramesa romana</i>]	Stem galler, field releases began in late 2017, establishment success unknown, further releases planned.
Giant reed scale [<i>Rhizaspidiotus donacis</i>]	Sap sucker, approved for release in 2017, first field release planned for spring 2018.
Gorse colonial hard shoot moth [<i>Pempelia genistella</i>]	Foliage feeder, from limited releases established only in Canterbury, impact unknown, but obvious damage seen at several sites.
Gorse hard shoot moth [<i>Scythris grandipennis</i>]	Foliage feeder, failed to establish from a small number released at one site, no further releases planned due to rearing difficulties.
Gorse pod moth [<i>Cydia succedana</i>]	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.
Gorse seed weevil [<i>Exapion ulicis</i>]	Seed feeder, common, destroys many seeds in spring.
Gorse soft shoot moth [<i>Agonopterix umbellana</i>]	Foliage feeder, common in parts of the SI with some impressive outbreaks seen, and well established and spreading at a site in Northland, impact unknown.
Gorse spider mite [<i>Tetranychus lintearius</i>]	Sap sucker, common, often causes obvious damage, but ability to persist is limited by predation.
Gorse stem miner [<i>Anisoplaca pytopterea</i>]	Stem miner, native, common in the SI, often causes obvious damage, lemon tree borer has similar impact in the NI.
Gorse thrips [<i>Sericothrips staphylinus</i>]	Sap sucker, common in many areas, impact unknown.
Heather beetle [<i>Lochmaea suturalis</i>]	Foliage feeder, established in and around Tongariro National Park [TNP], also Rotorua, 3,000ha heather damaged/killed at TNP since 1996, new strains more suited to high altitude released recently.
Hemlock moth [<i>Agonopterix alstromeriana</i>]	Foliage feeder, self-introduced, common, often causes severe damage.
Hieracium crown hover fly [<i>Cheilosia psilophthalma</i>]	Crown feeder, released at limited sites as difficult to rear, establishment success unknown.
Hieracium gall midge [<i>Macrolabis pilosellae</i>]	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.
Hieracium gall wasp [<i>Aulacidea subterminalis</i>]	Gall former, established but not yet common in the SI and not established yet in the NI, impact unknown but reduces stolon length in laboratory trials.

Hieracium plume moth [<i>Oxyptilus pilosellae</i>] Hieracium root hover fly [<i>Cheilosia urbana</i>] Hieracium rust [<i>Puccinia hieracii</i> var. <i>piloselloidarum</i>]	Foliation 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 [<i>Limenitis glorifica</i>] Japanese honeysuckle stem beetle [<i>Oberea shirahati</i>]	Foliation feeder, approved for release in 2013, releases began in 2014, well established and dispersing from site in the Waikato, further widespread releases planned. Stem miner, field releases began in 2017, difficult to rear so widespread releases will begin once harvesting from field is possible, establishment unknown.
Lantana blister rust [<i>Puccinia lantanae</i>] Lantana leaf rust [<i>Prospodium tuberculatum</i>] Lantana plume moth [<i>Lantanophaga pusillidactyla</i>]	Leaf and stem rust fungus, releases began autumn 2015, establishment success unknown. Leaf rust fungus, releases began autumn 2015, established well and causing severe defoliation already at several sites in Northland. Flower feeder, self-introduced, host range, distribution and impact unknown.
Mexican devil weed gall fly [<i>Procecidochares utilis</i>] Mexican devil weed leaf fungus [<i>Passalora ageratinae</i>]	Gall former, common, initially high impact but now reduced considerably by Australian parasitic wasp. Leaf fungus, probably accidentally introduced with gall fly in 1958, common and almost certainly having an impact.
Mist flower fungus [<i>Entyloma ageratinae</i>] Mist flower gall fly [<i>Procecidochares alani</i>]	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 [<i>Freudita cupripennis</i>] Moth plant rust [<i>Puccinia araujiae</i>]	Root feeder, approved for release in 2011 but not released yet due to difficulties gaining export permit, beetles recently sourced from Uruguay so releases expected to begin in 2019. Rust fungus, approved for release in 2015 but not released yet – waiting for export permit to be granted by Argentina.
Nodding thistle crown weevil [<i>Trichosirocalus horridus</i>] Nodding thistle gall fly [<i>Urophora solstitialis</i>] Nodding thistle receptacle weevil [<i>Rhinocyllus conicus</i>]	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 [<i>Phoma clematidina</i>] Old man's beard leaf miner [<i>Phytomyza vitalbae</i>] Old man's beard sawfly [<i>Monophadnus spinolae</i>]	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. Foliation feeder, limited releases as difficult to rear and only established in low numbers at one site in Nelson, more material will be imported in 2017 in an attempt to establish this insect more widely.
Privet lacebug [<i>Leptoypha hospita</i>]	Sap sucker, releases began spring 2015, establishment confirmed in Auckland and Waikato, some promising early damage seen already, widespread releases continuing.
Cinnabar moth [<i>Tyria jacobaeae</i>] Ragwort crown-boring moth [<i>Cochylis atricapitana</i>] Ragwort flea beetle [<i>Longitarsus jacobaeae</i>] Ragwort plume moth [<i>Platyptilia isodactyla</i>] Ragwort seed fly [<i>Botanophila jacobaeae</i>]	Foliation feeder, common in some areas, often causes obvious damage. Stem miner and crown borer, released widely, but 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 [<i>Chrysolina quadrigemina</i>] Lesser St John's wort beetle [<i>Chrysolina hypericif</i>] St John's wort gall midge [<i>Zeuxidiplosis giardi</i>]	Foliation feeder, common in some areas, not believed to be as significant as the lesser St John's wort beetle. Foliation feeder, common, nearly always provides excellent control. Gall former, established in the northern SI, often causes severe stunting.
Scotch thistle gall fly [<i>Urophora stylata</i>]	Seed feeder, released at limited sites, establishing and spreading readily, fewer thistles observed at some sites, impact unknown.
Tradescantia leaf beetle [<i>Neolema ogloblini</i>] Tradescantia stem beetle [<i>Lema basicostata</i>] Tradescantia tip beetle [<i>Neolema abbreviata</i>] Tradescantia yellow leaf spot [<i>Kordyana brasiliense</i>]	Foliation feeder, released widely since 2011, establishing well and beginning to cause noticeable or major damage at many sites already. Stem borer, releases began in 2012, establishing well with major damage seen at several sites already. Tip feeder, releases began in 2013, appears to be establishing readily, no significant impact observed yet. Leaf fungus, field releases only began in 2018, already some promising signs of likely establishment seen, further widespread releases planned.
Tutsan beetle [<i>Chrysolina abchasica</i>] Tutsan moth [<i>Lathronympha strigana</i>]	Foliation feeder, difficult to mass rear in captivity but field releases began in 2017 with more planned, establishment success unknown. Foliation and seed pod feeder, field releases began in 2017 with more planned, establishment success unknown.
Woolly nightshade lace bug [<i>Gargaphia decoris</i>]	Sap sucker, recently released widely, establishing readily at many sites, and beginning to cause significant damage at many sites.

Further Reading

Groenteman R 2018. Economics of horehound to New Zealand dryland farming. Manaaki Whenua – Landcare Research Contract Report LC3142 prepared for the Horehound Biocontrol Group. 16p.

Groenteman R, Probst C, Bellgard S, Prebble J 2017. Feasibility for biological control of horehound, *Marrubium vulgare* L. Manaaki Whenua – Landcare Research contract report LC3040 prepared for the Horehound Biocontrol Group. 70p.

Lange C, Podolyan A, Houlston G 2018. *Cirsium arvense* genotype population tracking in common garden experiment in New Zealand. Manaaki Whenua – Landcare Research Contract Report LC3117 prepared for AgResearch. 8p.

McAlpine KG, Timmins SM, Jackman SD, Lamoureaux SL 2018. Composition of the understory in 132 woody weed populations and implications for succession. New Zealand Journal of Ecology 42[2]. DOI: 10.20417/nzjcol.42.33

McAlpine KG, Lamoureaux SL, Timmins SM, Wotton DM 2018. Can a reduced rate of herbicide benefit native plants and control ground cover weeds? New Zealand Journal of Ecology 42[2]. DOI: 10.20417/nzjcol.42.34

Paynter Q, Fowler SV, Groenteman R 2018. Making weed biological control predictable, safer and more effective: perspectives from New Zealand. BioControl 63: 427–436. <https://doi.org/10.1007/s10526-017-9837-5>

Sutton GF, Paterson ID, Paynter Q 2017. Genetic matching of invasive populations of the African tulip tree, *Spathodea campanulata* Beauv. (Bignoniaceae), to their native distribution: Maximising the likelihood of selecting host-compatible biological control agents. Biological Control 114: 167–175. <http://dx.doi.org/10.1016/j.biocontrol.2017.08.015>

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

New Release of Identification Key for New Zealand Weeds

Manaaki Whenua – Landcare Research have relaunched their interactive key for the identification of weed species in New Zealand. The key contains over 650 weeds and over 10,000 images. Common weeds, environmental weeds, and all National Pest Plant Accord [NPPA] and Regional Pest Management Plan [RPMP] species are included. Significantly, this release fixes a major technical hitch: if you hit the “Run key” button it now works right out-of-the-box without the hassle of pesky Java installs. See: <https://www.landcareresearch.co.nz/resources/identification/plants/weeds-key>

Biocontrol Agents Released in 2017/18

Species	Releases made
Broom gall mite [<i>Aceria genistae</i>]	20
Darwin's barberry seed weevil [<i>Berberidicola exaratus</i>]	5
Field horsetail weevil [<i>Grypus equiseti</i>]	7
Giant reed gall wasp [<i>Tetramesa romana</i>]	5
Japanese honeysuckle white admiral [<i>Limenitis glorifica</i>]	13
Japanese honeysuckle stem beetle [<i>Oberea shirahati</i>]	1
Privet lace bug [<i>Leptoypha hospita</i>]	11
Tradescantia leaf beetle [<i>Neolema ogloblini</i>]	10
Tradescantia stem beetle [<i>Lema basicostata</i>]	5
Tradescantia tip beetle [<i>Neolema abbreviata</i>]	1
Tradescantia yellow leaf spot [<i>Kordyana brasiliense</i>]	7
Tutsan beetle [<i>Chrysomina abchasica</i>]	7
Total	92

