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Manaaki Whenua
Landcare Research

Weed Biocontrol

WHAT'S NEW?

Contents

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Trying Again with a Tough Tussock

Nassella tussock (*Nassella trichotoma*) is unpalatable to stock and reduces the livestock carrying capacity of infested pasture. This weed is not the easiest target for biological control, but a new Sustainable Farming Fund grant awarded to the Marlborough Farmers Nassella Tussock Group (but administered by Manaaki Whenua – Landcare Research) is allowing us to have another crack.

The weed is present in Auckland, Hawke's Bay and Northland, but is most problematic in the South Island, where it now infests at least 524,000 ha. Worryingly, mapping based on current climate patterns undertaken by AgResearch suggests this represents only 6% of its potential range in New Zealand. Climate change is likely to make the situation worse, as more frequent droughts predicted to occur on the east coast of New Zealand are likely to lead to increased bare ground and reduced competition from pasture grasses.

Managing nassella tussock is expensive, and usually involves manual removal (grubbing) of plants to keep weed populations below levels that are economically damaging. Recently the herbicide flupropoante has been introduced to New Zealand, but it has been found to cause damage to desirable pasture plants. Also, in Australia nassella tussock has developed resistance to this herbicide, and the same could happen here.

Biocontrol could potentially provide a more cost-effective and sustainable solution. "Modelling studies by AgResearch have shown that if we could reduce seeding by 10% and plant growth by 15% (reductions that should easily be achievable) that would result in a 76% reduction in the size of the Canterbury nassella tussock population," explained Seona Casonato, who is leading the new project.

Researchers and resources from three countries – Argentina, Australia and New Zealand – will be involved in this 3-year project. Argentina is the source of the weed, while Australia shares our desire to control it, having an even worse problem than New Zealand. The three countries have previously collaborated on biocontrol of the closely related Chilean needle grass (*Nassella neesiana*), which also originates in South America. This successful partnership led to the identification of a host-specific rust fungus (*Uromyces pencanus*), which we believe will make an excellent biocontrol agent for Chilean needle grass once it can be exported from Argentina.

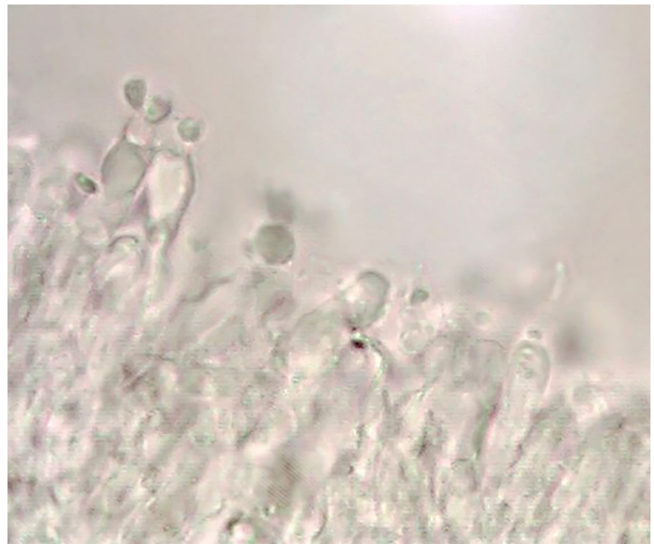
When seeking to use disease-causing micro-organisms (pathogens) to control weeds, there are two strategies that can be used: classical control and inundative control. Classical biocontrol involves finding a pathogen that damages the weed somewhere else (usually in its centre of origin) and then releasing it where it is needed. Classical biocontrol agents are expected to maintain and spread themselves once released. Inundative biocontrol, by contrast, uses pathogens that already occur on the weed where it is causing problems. Humans can help these pre-existing microbes to cause severe disease epidemics by formulating them to overcome unfavourable environmental conditions (e.g. a lack of moisture) and by applying them to the weed in large quantities (e.g. a million spores per millilitre of liquid). One draw-back of this method is that the help we provide needs to be ongoing. Still, a herbicide based on a pathogen (a bioherbicide) can be a useful tool, especially if the pathogen is relatively host specific, and so can be applied over non-target plants without damaging them (in contrast, for example, with the chemical herbicide flupropoante mentioned above). Because a bioherbicide is based on a complex living organism, it is also less likely that a weed would develop resistance to it.

For nassella tussock we intend trying both strategies. There have already been surveys undertaken in Argentina back in the 1990s looking for pathogens with potential as classical biocontrol agents. But when the three pathogens that seemed to have the most promise all looked decidedly less promising after further study, the limited funds were channelled towards Chilean needle grass instead. While our reasons for rejecting the rust fungus (*Puccinia nassellae*) and the smut fungus (*Tranzschelia* sp.) are still valid, technology has advanced considerably since the crown rot fungus was rejected for its intransigence in the lab and our inability to identify it. "We believe that if we could discover this pathogen again in Argentina, this time we could use molecular techniques to identify it. Once we know what sort of organism it is, this should help us to work out what conditions are needed to establish a colony in the glasshouse for further study," explained Freda Anderson (CERZOS-CONICET, Argentina), who has been involved with this project since the first surveys.

Consequently, new surveys in Argentina will be undertaken as part of the new project. Researchers will be looking particularly for this crown rot fungus, and other pathogens that appear to help it along in the field (e.g. *Fusarium* species), because it seems that when severe damage occurs it is due to a combination of pathogens and/or insects. "We will also look for the crown rot fungus in Australia as, after looking back through some old photos, I think I might have encountered it there more than 20 years ago," said Seona.

There is also another pathogen found on nassella tussock in Australia that might be useful for New Zealand. *Zinzipegasa argentinensis* was first described on a *Nassella* species in Argentina in 1911, so it was probably imported to Australia along with the weed. Given the problems we have been having getting permission to export other biocontrol agents from Argentina, it would be good to have an option of importing potential agents from just across the ditch. *Zinzipegasa argentinensis* causes black lesions on flowering stems of nassella tussock but doesn't cause enough damage on its own in Australia to be really useful. We will try to re-collect this fungus and test its pathogenicity on our nassella tussock plants in the hope that they are more susceptible to it, and see if damage can be increased when combined with other pathogens.

Suspected crown rot fungus in Australia we hope to find again



Basidiomata and basidiospores of the crown rot fungus under a microscope

The third prong in our planned attack is to try to develop one or more fungi we already have here as a bioherbicide. We surveyed nassella tussock in New Zealand in 2000 and found 42 fungi associated with it, but only six were judged to have caused disease symptoms and to be potentially host specific. None of these were identified to the species level, but were placed in the genera *Ascochyta* (one species), *Fusarium* (three species), *Phoma* (one species) and *Pyrenophora* (one species), and no further research was done. If these pathogens could be reisolated from the sites where they were collected previously, they could now be identified further (using molecular techniques) and tested as potential bioherbicides. The *Fusarium* species would be of particular interest, as such fungi may enhance the ability of the crown rot to kill host plants in Argentina, and perhaps we could encourage them to do the same here.

"What makes this project interesting is that it will combine all the 'old' knowledge of experienced researchers from three countries with 'new' technology," enthused Seona. Combining the classical and inundative techniques will also be a novel experience for New Zealand, but there is no reason why, with sufficient resources, it could not be done. Biocontrol will never eradicate a weed completely, but it would certainly be a welcome additional tool in our ongoing battle against this tough tussock.

This project is funded by the Sustainable Farming Fund administered by the Ministry for Primary Industries, with co-funding from Environment Canterbury, Marlborough District Council, the National Biocontrol Collective, Manaaki Whenua – Landcare Research, and the Victoria Serrated Tussock Working Party and AgriBioscience in Australia.

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Moth Plant Beetle Misconception Cleared Up

The potential to biologically control one of the North Island's worst weeds took a big step forward in May when the Environmental Protection Authority (EPA) granted a new approval to release a root-feeding beetle (*Freudeita cupripennis*) to combat moth plant.

"The beetle (initially misidentified as *Colaspis argentinensis*) first caught our attention as a possible biocontrol agent around a decade ago, but there have been difficulties getting the necessary approvals to export the beetle from Argentina and get releases underway in New Zealand," said Quentin Paynter. This meant that the original EPA approval for this beetle, granted in 2011, lapsed. When it became apparent in 2018 that we could source the beetle from Uruguay instead, the project was back on. As these beetles were from a different population, this meant repeating the host-range testing and then reapplying for permission to release," explained Quentin.

The Waikato Regional Council again acted as the applicant for the moth plant beetle. An unexpected number of submissions were made raising concerns that the moth plant beetle might also attack swan plant (*Gomphocarpus* spp.), a vital food plant for monarch butterflies. "We have tested swan plant and the other close relatives of moth plant present in New Zealand, such as native jasmine (*Parsonsia* spp.) and blood flower (*Asclepias curassavica*), and are confident that none of these plants are at risk," Quentin said. The only other species that is susceptible is the ornamental plant tweedia (*Oxypetalum caeruleum*), which is in the same sub-tribe as moth plant. Following a hearing in April to examine the evidence, the EPA determined that the only plant at risk of non-target damage from the moth plant beetle is tweedia, and that the benefits of controlling moth plant substantially outweigh this. If necessary, gardeners can protect tweedia plants with insecticide.

"We are now awaiting approval from the Ministry for Primary Industries to take the beetle out of containment and we anticipate the first field releases will be made in the spring," Quentin explained. "The moth plant beetle has a good chance of being an effective agent, given the success of other root-feeding beetles as weed biocontrol agents, and the high mortality rates of moth plants observed during host range testing and in the field in Uruguay," said Quentin.

A second agent being pursued is a fly (*Anastrepha australis*, formerly *Toxotrypana australis*), which can turn the contents of moth plant pods to mush. During a visit to Uruguay in February 2018, Hugh Gourlay collected a limited number of larvae. These produced adults that successfully mated in containment, although only a few adults were subsequently reared through to the next generation. A lack of pods on potted moth plants meant excised pods had to be used, which resulted in low rearing success. However, the emergence of new adults was synchronised with moth plant pod production here, which is a good sign that we will be able to successfully rear this fly in containment. We are holding off importing more flies until the potted plants are big enough to reliably produce plenty of pods.

However, last season we did some further work to assess whether the fly is likely to be sufficiently host specific to continue with, as host-testing agents that attack pods is logistically challenging. Hugh, with the assistance of an Argentinean collaborator, Soledad Vilamill, surveyed plants closely related to moth plant in Uruguay. They managed to find *Oxypetalum solanoides*, *O. tomentosum*, and *O. manchesii*, and none of these were hosting the fly. A database of host records maintained by USDA researcher Dr Allen Norrbom indicates that the only other plant *A. australis* has been reported to attack is *Morrenia odorata*, a very close relative of moth plant that is absent from New Zealand. "It certainly looks like the fly could be sufficiently host specific and is definitely worth pursuing further," added Quentin.

Finally, a rust fungus (*Puccinia araujiae*) approved for release in 2015 has also been held up by export permit issues. However, sourcing the rust from Uruguay is not so straightforward. In the native range the rust is attacked by a hyperparasitic fungus (*Cladosporium uredinicola*) and is not easy to find. Argentinian collaborator Freda Anderson (CERZOS-CONICET) has retained a culture of the rust that is free of the hyperparasite, achieved after much painstaking effort. If the rust could be collected in Uruguay it would be a massive undertaking to repeat all this work, let alone the host-range testing, but this option will be explored with the project funders in the near future.

This project is funded by the National Biocontrol Collective.

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Moth plant beetle

New Faces

Arnaud Cartier (Lincoln)

Arnaud joined us as an entomology technician in August 2017 after completing his MSc in Biodiversity, Behavioural Ecology and Evolution in his home country of France. Before coming here Arnaud worked briefly on the tobacco hornworm (*Manduca sexta*) at the Insect Biology Research Institute in Tours, France. Initially, Arnaud assisted with projects here seeking to biocontrol invasive wasps (*Vespula* spp.), but soon branched out into rearing weed biocontrol agents such as the tutsan moth (*Lathronympha strigana*) and a sawfly (*Monophadnus spinolae*) for old man's beard. Currently, Arnaud provides technical support to a range of weed biocontrol projects, such as Japanese honeysuckle (*Lonicera japonica*), tutsan (*Hypericum androsaemum*), alligator weed (*Alternanthera philoxeroides*), and tradescantia (*Tradescantia fluminensis*). Arnaud does a lot of the mass-rearing of agents for releases, and assists with managing the invertebrate containment facility at Lincoln.

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Chris McGrannachan (Auckland)

Chris joined us as a weed biocontrol scientist in March 2019, returning to his kiwi roots after studying and working at Monash University in Melbourne, Australia, for 7 years. Chris offers significant expertise in invasion ecology, having researched the impact of multi-species plant invasions on community structure and ecosystem processes in protected areas for his PhD. Chris also worked on Argentine ant (*Linepithema humile*) invasions in New Zealand while at Victoria University of Wellington for his undergraduate degree, and has conducted risk assessments on alien insects for the Invasive Species Council of Australia. Since joining us, Chris has helped to collect two insect biocontrol agents for Japanese honeysuckle (*Lonicera japonica*) in Japan: a beetle (*Oberea shirahatai*) and a moth (*Allotolanta* sp.). He has also explored the feasibility of biocontrol for yellow flag iris (*Iris pseudacorus*). Chris will also be involved in underpinning research to make biocontrol faster, safer and cheaper, and in a project to help biocontrol problem weeds in Vanuatu, including turkey berry (*Solanum torvum*), wild peanut (*Senna tora*), and hibiscus burr (*Urena lobata*).

CONTACT

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Angela Bownes (Lincoln)

Angela joined us at the beginning of July 2019, having moved to New Zealand from South Africa. Before making the big move, Angela worked as a weed biocontrol scientist for the Agricultural Research Council – Plant Health and Protection (ARC-PHP) in South Africa for 14 years, specialising in the biological control of aquatic weeds such as water hyacinth (*Eichhornia crassipes*) and hydrilla (*Hydrilla verticillata*). More recently she conducted research on giant reed (*Arundo donax*), an invasive grass species, and on a candidate biological control agent *Listronotus setosipennis* for parthenium weed (*Parthenium hysterophorus*) in Pakistan. Angela's expertise on aquatic plants will be put to good use as New Zealand has a considerable problem with aquatic weeds, many of which look to be good biocontrol targets. As a start, she'll join a project initiated by Quentin Paynter on the submerged aquatic plant oxygen weed (*Lagarosiphon major*), ironically also native to South Africa. Angela will also assist the biocontrol team with technology transfer activities, funding applications, and facilitating release approvals for new insect and weed biocontrol agents.

CONTACT

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Tackling Lesser Calamint with Biocontrol

A new biological control programme for lesser calamint (*Calamintha nepeta*) is underway in New Zealand thanks to funding granted to the Hawke's Bay Lesser Calamint Control Group (HBLCCG) by the Sustainable Farming Fund. A 2015 study on the feasibility of using biological control to tackle lesser calamint predicted the weed would be an intermediate target in terms of the chances of success. According to Ronny Groenteman, who did the feasibility study, "a lack of close relatives to lesser calamint in New Zealand increases the likelihood of finding agents that are sufficiently host specific." Lesser calamint is difficult to control with conventional weed management methods, so biocontrol is likely to be the best approach. The main challenge to overcome is that biocontrol has not been attempted for this weed before, and little information is available about potential biocontrol agents."

Lesser calamint is a member of the mint family, Lamiaceae, and is native to Europe, North Africa (Tunisia, Algeria, Morocco), Western Asia (Iran, Turkey), and the Caucasus. The plant is naturalised in New Zealand and the United States. First recorded in New Zealand in the 1940s, lesser calamint has spread across sheep and beef farms on the east coast of the North Island, and is currently having a serious economic impact on more than 100 farms in the Hawke's Bay area, according to Darin Underhill of the Hawke's Bay Regional Council. Lesser calamint is unpalatable to livestock and is strongly allelopathic, meaning that it produces toxic chemicals that suppress the growth of other plant species It therefore has a negative impact on important pasture species.

Sage leafhopper feeding damage on lesser calamint in Hawke's Bay (pale blotches). Leafhopper inset

Stephen Thorpe - leafhopper image

Lesser calamint grows particularly well in disturbed areas with low rainfall and can tolerate drought conditions. A climate model developed by Grant Humphries (Black Bawks Data Science Ltd) predicts that over 700,000 ha of sheep and beef land could eventually be infested by the weed in New Zealand if action to curb its spread is not taken. Simon Fowler, who conducted a cost–benefit analysis, said "based on the predicted rates of spread and pasture loss, lesser calamint could cost New Zealand sheep and beef farmers up to $1.5 million annually by 2030, rapidly increasing to over $15 million by 2040, and $100 million by 2050."

Funding for the 2-year HBLCCG project will be used to: identify the geographical origin of the lesser calamint population that has invaded New Zealand so that surveys for potential agents can be done in these areas; undertake surveys of lesser calamint throughout its current distribution range in New Zealand to identify any invertebrates or pathogens that might be using lesser calamint as a host plant, or that may potentially interfere with introduced biocontrol agents; and survey lesser calamint populations in the native range of Europe to identify and prioritise herbivorous invertebrates and plant pathogens that could be used as biocontrol agents in New Zealand. The control group is also committed to creating, and building on, community awareness and ownership of the project. So far progress has been good.

A DNA analysis comparing samples of lesser calamint from New Zealand to plant samples from the native range in Europe suggests that the New Zealand populations were introduced from Italy and/or France, and these areas should therefore be targeted for surveys for potential biocontrol agents. Focusing collections of invertebrates and pathogens from the area of origin of lesser calamint maximises the chances of finding agents that are well adapted to the plant in New Zealand, with the greatest potential for establishment and high impact.

In New Zealand, field surveys of lesser calamint are complete. According to Paul Peterson, who is leading the lesser calamint project, several herbivorous insects, none of which are specialist feeders, were found in small numbers on lesser calamint. However, two species, wheat bugs (*Nysius huttoni*) and sage leafhoppers (*Eupteryx melissae*), were found in high numbers at some sites. Wheat bugs, which are native to New Zealand and are common throughout the country, were found in very large numbers at two sites in the Hawke's Bay area, but occurred at lower densities at other sites. Sage leafhoppers were also present at every survey site, and in some cases caused noticeable damage to lesser calamint plants, particularly the older foliage (see photo). However, Paul said, "it is important to remember that outbreaks of generalist insects are usually a response to other factors rather than a density-dependent response to the target weed species, and thus they are unlikely to contribute to effective, long-term control of the weed." Likewise, all fungal pathogens that were collected are not specific to lesser calamint. "This research is important and valuable as it has shown us that there are currently no host-specific invertebrates or fungal pathogens feeding on lesser calamint in New Zealand that could be used for biocontrol," said Paul.

The second aim of the lesser calamint surveys in New Zealand was to assess the potential for other organisms, such as predators and parasitoids, to interfere with the establishment and spread of new biocontrol agents. Not surprisingly, generalist predators, particularly spiders, were abundant on lesser calamint, but, more importantly, a number of parasitiods were reared from lepidopteran (moth or butterfly) larvae. This means that any species of lepidoptera released for biological control of lesser calamint would have a high risk of being parasitised and should be avoided. "For example, the parasitic wasp *Meteorus pulchricornis* is known to have a very wide host range and has been recorded from eight lepidopteran families in New Zealand, while another parasitic wasp, *Trigonospila brevifacies*, is known to parasitise at least 18 species of lepidoptera in eight families," said Chris Winks, who helped with the surveys.

Surveys conducted by CABI-Switzerland in the native range to identify natural enemies of lesser calamint yielded some promising candidates. Specialist insects feeding on lesser calamint that were regularly encountered included a leaf-mining buprestid beetle (*Trachys menthae*) and a flower gall midge (*Asphondylia nepetae*). The gall midge is commonly parasitised by a wasp, but this is not a concern for New Zealand because insect biocontrol agents are carefully screened to ensure they are released without their own natural enemies from the native range. Another common insect found feeding on lesser calamint in southern France was an unidentified stem-mining moth. Because of the high risk of parasitism of lepidopteran biocontrol agents in New Zealand, this stem-mining moth will be of low priority for consideration as a biocontrol agent for lesser calamint in New Zealand.

Larva of a flower gall midge (*Asphondylia nepetae*)

Further surveys to source potential biocontrol agents for lesser calamint will focus on France and Italy and will be completed by February 2020. "At this time, we will have a clearer idea of which invertebrate and pathogen species should be selected as biocontrol candidates for lesser calamint in New Zealand. The project will then move to the next stage, focusing on host-range testing of the most promising potential agents," said Paul.

This project is funded by the Sustainable Farming Fund, which is administered by the Ministry for Primary Industries.

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CABI

Larva (left) of a leaf-mining beetle (*Trachys menthae*) found at several sites in southern France, and typical damage (right).

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*)

- We think this beetle has established quite widely but is not abundant and we are keen to know more about this. 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 100–200 beetles to sites that are not yet infested with gall mites.

Broom shoot moth (*Agonopterix assimilella*)

- We are unsure if this moth has managed to successfully establish in New Zealand, so we will be interested to hear if anyone can find any sign of them. 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.

Darwin's barberry weevil (*Berberidicola exaratus*)

- Since these weevils are difficult to mass-rear we are attempting to establish them at a couple of field sites from which they can later be harvested and redistributed to all areas where they are needed. We are therefore very interested to know if establishment can be confirmed.
- Beat plants at release sites later in the spring to see if any of the small (3–4 mm long), blackish adults can be found. Also examine the fruits for signs of puncturing. Please let us know what you find.

Giant reed gall wasp (*Tetramesa romana*)

- Although it is early days, it is 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. The galls often have small, circular exit holes made by emerging wasps.
- It will probably be too soon to consider harvesting and redistribution if you do see evidence of the gall wasp establishing.

Japanese honeysuckle white admiral (*Limenitis glorifica*)

- 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. You will need to aim to shift at least 1,000 caterpillars to start new sites. The butterflies are strong fliers and are likely to disperse quite rapidly without any assistance.

Broom shoot moth larva

Lantana blister rust (*Puccinia lantanae*)

- We do not yet have any evidence that the blister rust has established and are keen to hear if symptoms can be found in the field. 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*)

- 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 a 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, stem and tip beetles (*Neolema ogloblini, Lema basicostata, N. abbreviata*)

- Look for the distinctive feeding damage and adults. For the leaf and tip beetles, look for the external-feeding larvae, which have a distinctive faecal shield on their backs.
- If you find them in good numbers, aim to collect and shift at least 100–200 beetles using a suction device or a small net. For stem beetles it might be easier to harvest infested material and wedge this into tradescantia at new sites (but make sure you have an exemption from MPI that allows you to do this).

Tradescantia yellow leaf spot (*Kordyana brasiliensis*)

- Although the fungus has only been released a short time at many release sites, promising signs of likely establishment have been seen at some sites after only a few months, so it is worth taking a look 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.
- The fungus is likely to disperse readily via spores on air currents. If human-assisted distribution is needed in the future, again you will need permission from MPI to propagate and transport tradescantia plants. 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.

Tutsan beetle (*Chrysolina abchasica*)

- It is early days for most tutsan beetle release sites, but the best time to look for this agent is spring through to mid-summer. Look for leaves with notched edges or whole leaves that have been eaten away. The iridescent purple adults are around 10–15 mm in size, but they spend most of the day hiding away so the damage may be easier to spot. Look also for the creamy-coloured larvae, which are often on the underside of the leaves. They turn bright green just before they pupate.

Tutsan beetle larva and damage

Tutsan moth (*Lathronympha strigana*)

- We do not yet know if the tutsan moth has established so are keen to hear how they are doing in the field. Look for the small orange adults flying about flowering tutsan plants. They have a similar look and corkscrew flight pattern to the gorse pod moth (*Cydia succedana*). Look also for fruits infested with the larvae.

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*)

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

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Who's Who in Biological Control of Weeds?

Alligator weed beetle [*Agasicles hygrophila*]	Foliage feeder, common, often provides excellent control on static water bodies.
Alligator weed beetle [*Disonycha argentinensis*]	Foliage feeder, released widely in the early 1980s, failed to establish.
Alligator weed moth [*Arcola malloi*]	Stem borer, common in some areas, can provide excellent control on static water bodies.
Blackberry rust [*Phragmidium violaceum*]	Leaf rust fungus, self-introduced, common in areas where susceptible plants occur, can be damaging but many plants are resistant.
Boneseed leaf roller [*Tortrix* s.l. sp. "*chrysanthemoides*"]	Foliage feeder, established and quite common at some North Island (NI) sites but no significant damage yet, limited by predation and parasitism.
Bridal creeper rust [*Puccinia myrsiphylli*]	Rust fungus, self-introduced, first noticed in 2005, widespread and providing good control.
Broom gall mite [*Aceria genistae*]	Gall former, becoming widespread in some regions, showing considerable promise by beginning to cause extensive damage to broom at many sites.
Broom leaf beetle [*Gonioctena olivacea*]	Foliage feeder, establishment confirmed at sites in both islands but not yet common, impact unknown.
Broom psyllid [*Arytainilla spartiophila*]	Sap sucker, becoming common, some damaging outbreaks seen, but may be limited by predation, impact unknown.
Broom seed beetle [*Bruchidius villosus*]	Seed feeder, common in many areas, now destroying up to 84% of seeds at older release sites.
Broom shoot moth [*Agonopterix assimilella*]	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 [*Leucoptera spartifoliella*]	Stem miner, self-introduced, common, often causes obvious damage.
Californian thistle flea beetle [*Altica carduorum*]	Foliage feeder, released widely during the early 1990s, failed to establish.
Californian thistle gall fly [*Urophora cardui*]	Gall former, extremely rare as galls tend to be eaten by sheep, impact unknown.
Californian thistle leaf beetle [*Lema cyanella*]	Foliage feeder, only established at one site near Auckland, where it causes obvious damage and from which it is dispersing, and possibly one site in the Hawke's Bay.
Californian thistle rust [*Puccinia punctiformis*]	Systemic rust fungus, self-introduced, common, damage usually not widespread.
Californian thistle stem miner [*Ceratapion onopordi*]	Stem miner, attacks a range of thistles, released at limited sites as difficult to rear, establishment success unknown.
Green thistle beetle [*Cassida rubiginosa*]	Foliage feeder, attacks a range of thistles, released widely and some damaging outbreaks beginning to occur.
Chilean needle grass rust [*Uromyces pencanus*]	Rust fungus, approved for release in 2011 but not released yet – waiting for export permit to be granted by Argentina, only South Island (SI) populations likely to be susceptible.
Darwin's barberry flower bud weevil [*Anthonomus kuscheli*]	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 [*Berberidicola exaratus*]	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 [*Grypus equiseti*]	Foliage and rhizome feeder, field releases began in 2017, establishment success unknown, further releases planned.
Giant reed gall wasp [*Tetramesa romana*]	Stem galler, field releases began in late 2017, establishment success unknown, further releases planned.
Giant reed scale [*Rhizaspidiotus donacis*]	Sap sucker, approved for release in 2017, first field release planned for spring 2019.
Gorse colonial hard shoot moth [*Pempelia genistella*]	Foliage feeder, from limited releases established only in Canterbury, impact unknown, but obvious damage seen at several sites.
Gorse hard shoot moth [*Scythris grandipennis*]	Foliage feeder, failed to establish from a small number released at one site, no further releases planned due to rearing difficulties.
Gorse pod moth [*Cydia succedana*]	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 [*Exapion ulicis*]	Seed feeder, common, destroys many seeds in spring.
Gorse soft shoot moth [*Agonopterix umbellana*]	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 [*Tetranychus lintearius*]	Sap sucker, common, often causes obvious damage, but ability to persist is limited by predation.
Gorse stem miner [*Anisoplaca ptyoptera*]	Stem miner, native, common in the SI, often causes obvious damage, lemon tree borer has similar impact in the NI.
Gorse thrips [*Sericothrips staphylinus*]	Sap sucker, common in many areas, impact unknown.
Heather beetle [*Lochmaea suturalis*]	Foliage feeder, established in and around Tongariro National Park (TNP), also Rotorua, 5,000 ha heather damaged/killed at TNP since 1996, new strains more suited to high altitude released recently.
Hemlock moth [*Agonopterix alstromeriana*]	Foliage feeder, self-introduced, common, often causes severe damage.
Hieracium crown hover fly [*Cheilosia psilophthalma*]	Crown feeder, released at limited sites as difficult to rear, establishment success unknown.
Hieracium gall midge [*Macrolabis pilosellae*]	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 [*Aulacidea subterminalis*]	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 [*Oxyptilus pilosellae*]	Foliage feeder, only released at one site due to rearing difficulties, did not establish.

Hieracium root hover fly (*Cheilosia urbana*) Hieracium rust (*Puccinia hieracii* var. *piloselloidarum*)	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.
Horehound clearwing moth (*Chamaesphecia mysinformis*) Horehound plume moth (*Wheerleria spilodactylus*)	Root feeder, released at limited sites in late 2018, establishment success unknown. Foliage feeder, released at limited sites in late 2018, establishment success unknown.
Japanese honeysuckle white admiral (*Limenitis glorifica*) Japanese honeysuckle stem beetle (*Oberea shirahatai*)	Foliage feeder, field releases began in 2014, already well established and dispersing from site in the Waikato, widespread releases now underway. 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 (*Puccinia lantanae*) Lantana leaf rust (*Prospodium tuberculatum*) Lantana plume moth (*Lantanophaga pusillidactyla*)	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 (*Procecidochares utilis*) Mexican devil weed leaf fungus (*Passalora ageratinae*)	Gall former, common, initially high impact but now reduced considerably by Australian parasitic wasp. Leaf fungus, probably accidentally introduced with gall fly in 1958, common and almost certainly having an impact.
Mist flower fungus (*Entyloma ageratinae*) Mist flower gall fly (*Procecidochares alani*)	Leaf smut, common and often causes severe damage. Gall former, common now at many sites, in conjunction with the leaf smut provides excellent control of mist flower.
Moth plant beetle (*Freudita cupripennis*) Moth plant rust (*Puccinia araujiae*)	Root and foliage feeder, approved for release in 2011 but not released due to difficulties gaining export permit, new approval to release granted in 2019 after beetles were sourced from Uruguay, first field release expected to be made in late 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 (*Trichosirocalus horridus*) Nodding thistle gall fly (*Urophora solstitialis*) Nodding thistle receptacle weevil (*Rhinocyllus conicus*)	Root and crown feeder, becoming common on several thistles, often provides excellent control in conjunction with other thistle agents. Seed feeder, becoming common, can help to provide control in conjunction with other thistle agents. Seed feeder, common on several thistles, can help to provide control of nodding thistle in conjunction with other thistle agents.
Old man's beard bud-galling mite (*Aceria vitalbae*) Old man's beard leaf fungus (*Phoma clematidina*) Old man's beard leaf miner (*Phytomyza vitalbae*) Old man's beard sawfly (*Monophadnus spinolae*)	Gall former which stunts the new growth, approved for release in 2019, it is hoped the first field release can be made in late 2019. Leaf fungus, initially caused noticeable damage but has become rare or died out. Leaf miner, common, damaging outbreaks occasionally seen, but appears to be limited by parasitism. Foliage feeder, limited releases as difficult to rear and only established in low numbers at a site in Nelson, more released in North Canterbury in 2018 in attempt to establish it more widely.
Privet lacebug (*Leptoypha hospita*)	Sap sucker, releases began spring 2015, establishment confirmed in Auckland and Waikato, some promising early damage seen already, widespread releases continuing.
Cinnabar moth (*Tyria jacobaeae*) Ragwort crown-boring moth (*Cochylis atricapitana*) Ragwort flea beetle (*Longitarsus jacobaeae*) Ragwort plume moth (*Platyptilia isodactyla*) Ragwort seed fly (*Botanophila jacobaeae*)	Foliage feeder, common in some areas, often causes obvious damage. Stem miner and crown borer, released widely, 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 (*Chrysolina quadrigemina*) Lesser St John's wort beetle (*Chrysolina hyperici*) St John's wort gall midge (*Zeuxidiplosis giardi*)	Foliage feeder, common in some areas, not believed to be as significant as the lesser St John's wort beetle. Foliage feeder, common, nearly always provides excellent control. Gall former, established in the northern SI, often causes severe stunting.
Scotch thistle gall fly (*Urophora stylata*)	Seed feeder, released at limited sites but becoming common, fewer thistles observed at some sites, impact unknown.
Tradescantia leaf beetle (*Neolema ogloblini*) Tradescantia stem beetle (*Lema basicostata*) Tradescantia tip beetle (*Neolema abbreviata*) Tradescantia yellow leaf spot (*Kordyana brasiliensis*)	Foliage 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 began in 2018 and are continuing, establishment confirmed at several sites and promising damage seen already at one site in the Waikato.
Tutsan beetle (*Chrysolina abchasica*) Tutsan moth (*Lathronympha strigana*)	Foliage feeder, difficult to mass rear in captivity so limited field releases made since 2017, establishment success unknown. Foliage and seed pod feeder, field releases began in 2017 with good numbers released widely, establishment success unknown.
Woolly nightshade lace bug (*Gargaphia decoris*)	Sap sucker, recently released widely, establishing readily at many sites and becoming common, beginning to cause significant damage at many shaded sites.

Further Reading

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Lam W, Paynter Q, Zhang Z.-Q 2019. **Predation, prey preference and reproduction of predatory mites *Amblydromalus limonicus* (Garman), *Amblyseius herbicolus* (Chant) and *Neoseiulus cucumeris* (Oudemans)(Mesostigmata: Phytoseiidae) on immature S*ericothrips staphylinus* Haliday (Thysanoptera: Thripidae), a biocontrol agent of gorse.** Systematic and Applied Acarology 24: 508–519. https://dx.doi.org/10.11158/saa.24.3.14

McGrannachan C 2019. **Feasibility of biological control of yellow flag iris, *Iris pseudacorus* L.** Manaaki Whenua – Landcare Research Contract Report LC3487 prepared for Waikato Regional Council. 63p.

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Paynter Q, Peterson P, Cranwell S, Winks C, McGrath Z 2019. **Impact of generalist predation on two recently established weed biocontrol agents in New Zealand.** New Zealand Plant Protection 72: 260–264. https://doi.org/10.30843/nzpp.2019.72.258

Paynter Q, Teulon D 2019. **Laboratory tests to estimate the non-target impacts of four *Aphidius* spp. parasitoids in the field.** Biological Control 133: 41–49. https://doi.org/10.1016/j.biocontrol.2019.03.007

Sheppard AW, Paynter Q, Mason P, Murphy S, Stoett P, Cowan P, Brodeur J, Warner K, Villegas C, Shaw R, Hinz H, Hill, M , Genovesi P 2018. **The application of classical biological control for the management of established invasive alien species causing environmental impacts.** Information Document for the Convention on Biological Diversity. IUCN SSC Invasive Species Specialist Group. https://www.cbd.int/doc/c/0c6f/7a35/eb8815eff54c3bc4a02139fd/cop-14-inf-09-en.pdf

Winks C, Bellgard S, Groenteman R, Probst C, Smith L, Gourlay H 2018. **Invertebrates and fungal pathogens associated with horehound, *Marrubium vulgare* L. (Lamiaceae), in New Zealand.** Manaaki Whenua – Landcare Research Contract Report LC3266 prepared for Horehound Biocontrol Group. 27p.

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Biocontrol Agents Released in 2018/19

Species	Releases made
Field horsetail weevil [*Grypus equiseti*]	2
Giant reed gall wasp [*Tetramesa romana*]	2
Horehound clearwing moth [*Chamaesphecia mysinformis*]	5
Horehound plume moth [*Wheerleria spilodactylus*]	8
Japanese honeysuckle stem beetle [*Oberea shirahatai*]	1
Japanese honeysuckle white admiral [*Limenitis glorifica*]	16
Old man's beard sawfly [*Monophadnus spinolae*]	1
Privet lace bug [*Leptoypha hospita*]	16
Tradescantia leaf beetle [*Neolema oglobini*]	17
Tradescantia tip beetle [*Neolema abbreviata*]	2
Tradescantia yellow leaf spot [*Kordyana brasiliensis*]	24
Tutsan beetle [*Chrysolina abchasica*]	5
Tutsan moth [*Lathronympha strigana*]	2
Total	**101**