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Weed Biocontrol

WHAT'S NEW?

Contents

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Galls of the Scotch broom gall mite

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Keeping Track of the Adventive Plant Species in New Zealand

New Zealand (NZ) has a rich adventive seed plant (seed-bearing plant or Spermatophyte) flora, outnumbering the native seed plant flora by over 600 species. A total of 3950 seed plant species are permanently established in the wild in NZ, 1815 of which are endemic, 320 are indigenous but not endemic (these species occur naturally in NZ but also in other regions of the world), and 2850 are adventive/exotic/non-indigenous.

The term 'adventive' is derived from the Latin *advena*, meaning a stranger or immigrant. It can therefore be applied to all non-indigenous/exotic wild plants growing in NZ, since all have had an 'advent'. Some of these introduced plant species become fully naturalised, while others never establish, being collected once and never seen again. Some remain at the site where they were first introduced, likely finding the conditions marginal and lacking the means of dispersal to transfer them to areas with more favourable conditions for growth. If an adventive species forms self-sustaining populations in its new geographical area it is termed 'naturalised'. Generally, naturalised plants are viewed as weeds.

The adventive flora of NZ was either accidentally introduced (e.g. in stock feed), or deliberately introduced for various purposes (e.g. ornamental or dune stabilisation) and later escaped cultivation. Many early accidental introductions were of temperate weeds that became widespread, accompanying settlers or arriving as stowaways with crop seed, cargo, and ballast. The first plants to become naturalised in NZ were those brought here by Polynesian settlers, but following European settlement there was a rapid increase in the number of naturalised species.

The adventive flora of NZ primarily occupies lowlands, wastelands, roadsides, farms, gardens, and other disturbed and modified places where native plants have been displaced because of human activities. In part, the success of introduced plant species in NZ can be attributed to the paucity of native species, particularly annuals, that rapidly occupy continuously disturbed habitats. NZ's equable climate and wide range of latitudes have allowed a great diversity of species to become established. Over the last 250 years, plants from all continents except Antarctica have found their way to NZ and have become naturalised. In many cases, weedy species have not come directly to NZ from their area of endemism, but came indirectly via other countries (notably Britain and Australia) where they are also naturalised.

With their observations of the diversity and rapid increase in the number of naturalised plant species in NZ, early botanists feared they would threaten the survival of native flora. "Records of the introduction and naturalisation of seed plant species have come from many sources, varying in accuracy," explained Ines Schönberger, Manager of the Allan Herbarium. "A foundation was laid in the writings of botanists Thomas Kirk (1871) and Thomas Cheeseman (1883), and with their voucher specimens in NZ herbaria. These specimens, and those of later collectors, specify collection dates, elucidating when certain species were known to be in NZ, and serving as voucher specimens for accuracy of identification," she added. Much later, the *Flora of New Zealand* Vol. IV (1995) by Colin Webb and colleagues was the first comprehensive treatment of naturalised plants in NZ since HH Allan's *Handbook of the Naturalised Flora of New Zealand* of 1940.

The Allan Herbarium

Webb's book covered 1470 naturalised species, summarising the findings of publications and checklists by several authors from 1943 to 1988.

The invasion of exotic plants did not stop there. It has been continuing at a rapid pace, with new records of naturalisations published in various checklists from 1988 onwards. For example, another 398 species were added to the list between 1994 and 2006, in five checklists produced by Peter Heenan and colleagues. In 2021 another 42 plant species were added to the list of naturalised plants, and so far this year another 15 species have been recorded as naturalised in NZ.

The adventive flora will, of course, continue to change. Some species have disappeared from the flora as a result of changing agricultural practices, and new species will become naturalised. The rate of new naturalisations shows no sign of abating, so it is expected that the list will continue to grow accordingly. Approximately 30,000 exotic plants (including all cultivated food plants and ornamentals) are already in NZ, and new, non-native species will continually enter the country and become established, although some may not persist or may remain innocuous.

To anticipate population explosions of these often potentially harmful weeds, it is important to accurately track their presence and spread. Much attention has been paid to the negative effects of adventive species on native ecosystems, but studies seeking to find out when and where these species started to become naturalised are scarce. Similarly, accurate distribution data of adventive plant species are not easy to find. The Allan Herbarium (and other herbaria) address these issues by providing access to primary specimen data. Herbarium specimens are among the most accessible and verifiable sources of data on distribution and habitat. A herbarium specimen is a voucher documenting a species growing at a given site at a certain time.

Herbarium data, increasingly available in digital format, allows us to attempt to reconstruct invasion histories, and to determine periods of species influx, invasion extents, and invasion niche shifts. The Systematics Collections Data website provides access to specimens from the Allan Herbarium (https://scd.landcareresearch.co.nz). This website is intended primarily for researchers and workers who require access to 'unsanitised' collection data. However, high-resolution images of some specimens are available to enable everybody to observe information first hand without having to interpret herbarium label information. By providing images of the actual specimens, identifications and confirmations are made possible.

Tracking the introduction and spread of adventive species increasingly plays a vital role in both basic research and applied fields. A strong collection of herbarium specimens is the critical resource necessary to examine such floristic changes and to identify new potential weeds. Herbarium specimens can help determine how fast weeds spread, provide evidence that a lag phase in the spread of weeds exists, and help estimate the length of such lag phases.

Euphorbia paralias herbarium specimen

So where do our herbarium specimens come from? Specimens and associated collection data are submitted by plant taxonomists, ecologists, Department of Conservation staff, horticulturalists, farmers, members of the public, and biosecurity officers. "In recent years biosecurity officers have been contributing significantly to the Allan Herbarium by using the Plant Identification Service offered to members of the National Biocontrol Collective. Fresh plant specimens are sent to the herbarium for identification, confirmation, and accessioning," said Ines.

Biosecurity officers check areas of land for harmful plants and arrange for, or help with, pest destruction and control. On average, the Allan Herbarium receives 400–600 plant samples per year from the biosecurity officers for identification. "Recently, we have received additional specimens of Chilean needle grass (*Nassella neesiana*) as evidence of its range expansion; a "wild" pineapple plant (*Ananas comosus*) was collected in Taranaki; biosecurity officers found a specimen of cascara (*Frangula purshiana*) growing wild in a pine forest in Hiwipango, Nelson – a species that was last collected in this area in 1981; common reed (*Phragmites karka*) is taking off in the Wellington region; the first naturalised water figwort (*Scrophularia auriculata*) population has been found in Southland; and biosecurity officers have been collecting and sending in sea spurge (*Euphorbia paralias*) specimens, highlighting the threat of this species to New Zealand's coastal ecosystems," said Ines. "These are only very few examples, but they demonstrate how important it is to have ears, eyes, and hands on the ground to assist us with keeping track of the adventive seed plant flora in New Zealand," she concluded.

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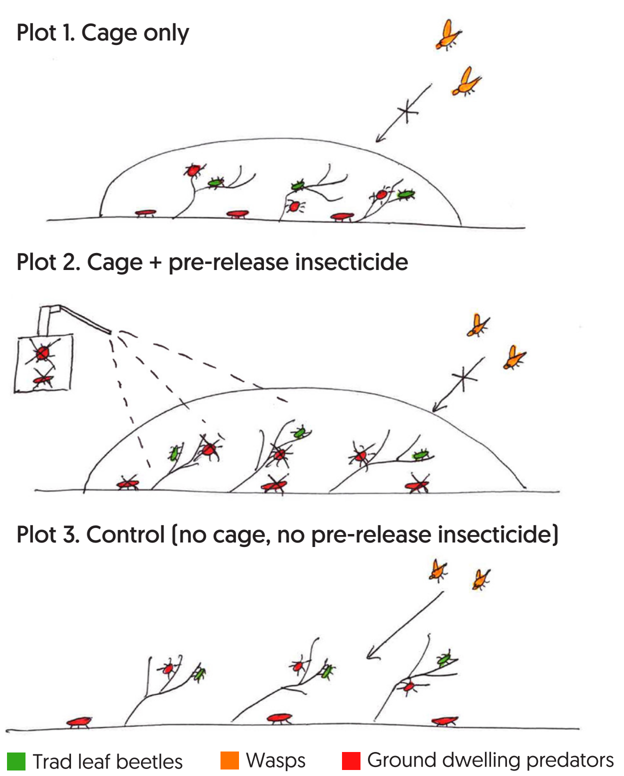
Predation and the tradescantia leaf beetle

The success of the tradescantia leaf beetle (*Neolema ogloblini*) has been highly variable in several regions of the country. Beetle predation has been implicated in their failure to establish at some sites. Invasive common and German wasps (*Vespula* spp.), paper wasps (*Polistes* spp.), shield bugs and stink bugs, and spiders are all suspected to be potential predators.

To determine if predation is an important factor in the success of the tradescantia leaf beetle, we set up an experiment in the Manawatū–Whanganui region. For the experiment, nine sites in a range of different habitats were selected, some of which had willow trees with giant willow aphids (*Tuberolachnus salignus*), which are known to support large wasp densities. At each site, three plots (0.25 m^2) with tradescantia (*Tradescantia fluminensis*) infestations were set up approximately 100 m apart. Two of the three plots had different treatments applied: (i) a protective cage covering the plots to exclude flying predators such as wasps; and (ii) a protective cage covering the plots and a pre-release insecticide treatment (non-residual Kiwicare Organic Insect Control with pyrethrum) to kill any ground-dwelling predators. The third plot at each site was a control, where no treatments were applied (i.e no cage and no insecticide).

Approximately 8 weeks after the insecticide treatments were applied, in January 2020, 100 tradescantia leaf beetles were added to each of the three plots at all nine sites. The sites were visited several times until the summer of 2022 to make observations, look for signs of ground-dwelling predator activity, and record any leaf beetle damage or sightings. Wasp traps were also deployed during the summer of 2021, and a 5-minute wasp count was made during May 2021.



Experimental design

Of the nine beetle releases that were made in the control plots, only four established (44%), whereas 14 out of 18 releases (78%) in the plots that had cages established – seven from each treatment. Nine months after the releases took place, feeding damage in some of the caged plots was so severe that the cages needed to be lifted to allow some beetles to escape. Evidence of beetle persistence and population growth from a few of these plots was difficult to find, or was not found again, probably because the cages were not removed soon enough and the beetles starved. Of the four successful releases in the control plots, the plants had very little damage during the first 9-month period.

Common wasps (*Vespula vulgaris*) were recorded at eight of the nine experimental sites, and were found in close proximity to 15 of the 27 plots where the leaf beetles were released. Of the four successful control releases, three established in the presence of wasps and one of the five failures occurred in a wasp-free area. Caged beetle populations persisted at several sites following cage removal, despite very high wasp densities (over 30 wasps in a 5-minute count). One of these sites was less than 10 m away from the entrance of a very large wasp nest. Ground dwelling predators were also present but did not appear to limit population growth of the beetles.

Although caged releases were more successful than releases in the control plots, the rapid population build-up of beetles in cages could be unrelated to a reduction in predation pressure. The Allee effect, which is characterised by a correlation between population density and fitness of a population, is a possible alternative explanation. Allee effects can range from behavioural to physiological factors and, in the case of low insect densities, may result in a lack of mating opportunities. Given the rapid population growth of leaf beetles when caged, and a lack of direct evidence to suggest predation is limiting population growth when the cages are removed, it is possible that we avoided an Allee effect by initially keeping the leaf beetles in a confined space, thereby improving the chances of population survival. As a result, we recommend tradescantia leaf beetles be caged or confined for one generation after their release to increase the chance they will establish. However, a close eye needs to be kept on the population to ensure the beetles don't eat all the leaf material inside the cages and die out before being freed.

This project was funded by the Ministry of Business, Innovation and Employment as part of Manaaki Whenua – Landcare Research's Beating Weed Programme.

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A Fresh Search for Old Man's Beard Pathogens

In 1996 a leaf fungus called '*Phoma clematidina* isolate' was collected in the USA and released in NZ for the biocontrol of old man's beard (*Clematis vitalba*). This fungal isolate initially caused significant damage at some of the release sites, but after some time it became evident that it had not persisted. The most plausible explanation is that the fungus was outcompeted by other fungi that occur on old man's beard; for example, symptomless endophtyes that confer disease resistance to plants.

Although two invertebrate biocontrol agents (a mite, *Aceria vitalba*, and a sawfly, *Monophadnus spinolae*) are now established on old man's beard the severity of the problem in NZ warrants further investigation into a damaging plant pathogen that will hopefully complement the damage of the two agents now present.

Collaborators at the Centre for Agriculture and BioScience International (CABI) in the United Kingdom (UK) have been contracted to conduct exploratory work in the native range in the search for plant pathogens as potential biocontrol agents for old man's beard. The first step included a desktop study to catalogue information about plant pathogens previously recorded from old man's beard. Dr Sarah Thomas (plant pathologist, CABI) conducted a literature review and database search, as well as a visit to Kew Herbarium, to catalogue the pathogens recorded from old man's beard. A total of 252 old man's beard specimens from 25 countries are contained in the collection at Kew, some dating back to the 1800s. Specimens from the United Kingdom, Russia, Germany, Switzerland, Austria, Hungary, Romania, Holland, Belgium, France, Italy, Sicily, Portugal, Spain, Yugoslavia, Bulgaria, Greece, Crete, Turkey (Europe), the Caucasus, Persia, Syria, Lebanon, and Cyprus were examined. Many specimens displayed symptoms similar to those commonly observed during the original field surveys.

A climate modelling study to identify the most climatically suitable regions of Europe to undertake field surveys was also completed by CABI. The software CLIMEX was used to match climatically similar regions in NZ and the native range of old man's beard in France, Ireland, Spain, Portugal and the UK.

Old man's beard has an extensive native distribution, so genetic matching of plant populations in NZ and the native range also helped to narrow the search area. An earlier study suggested that old man's beard plants in NZ may have originated from Italy, the UK, Germany, and France. CABI will collect plant samples during their field surveys for further analysis to pinpoint populations in the collection areas that both yielded promising pathogens and are closely related to NZ old man's beard.

The first field surveys for old man's beard pathogens began in the UK in April 2021, but it turned out to be a very cold spring with several frosts, which delayed budding of old man's beard plants until the end of May. Surveys were started again in early June, with a number of field trips carried out in England and Wales. Travel between European countries was still difficult at this time due to pandemic restrictions, but Dr Marion Seier (plant pathologist, CABI) managed a short visit to Germany in August that same year. Symptoms observed in the field in the UK and Germany consisted of dark brown to black lesions, infecting both the leaves and stems of old man's beard plants. However, there was variation in the size and shape of these lesions and the amount of associated yellowing.

From the limited number of surveys so far it appears that the most abundant fungal pathogen present on old man's beard is what we have known as '*Phoma clematidina*'. However, molecular testing identified a subset of the isolates as *Longididymella vitalbae*. The taxonomy of the *Longididymella* genus is extremely complex, but, briefly, this pathogen is the one that was originally described from old man's beard plants from Europe (Switzerland, France, Germany, and the Netherlands), while the plant pathogen '*Phoma clematidina* isolate' released in 1996 as a biocontrol agent in NZ is now classified as a different species in the *Longididymella* genus (*Longididymella clematidis*).

Our UK collaborators are surveying in Spain, Italy, and Ireland from July onwards to expand the search for plant pathogens, and to collect leaf samples for the molecular work. Recently, seeds were sent to CABI for propagating old man's beard plants from NZ. They'll also grow plants from Europe to develop an inoculation methodology, enabling them to determine whether the key promising pathogens cause disease symptoms on NZ plants.

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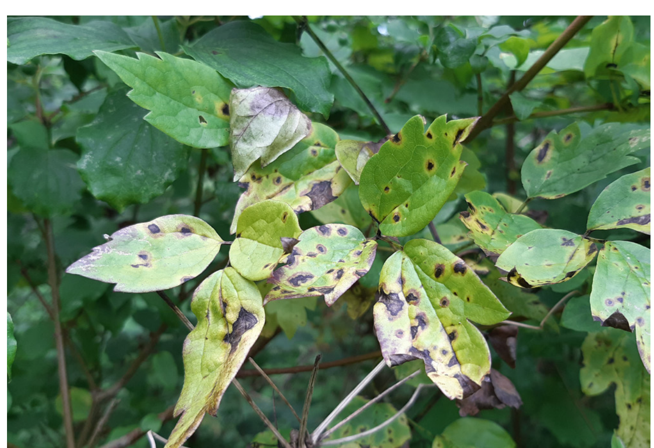

Old man's beard pathogen symptoms

It Established After All!

The boneseed leafroller (*Tortrix* s.l. sp. "*chrysanthemoides*") is a moth that was released as a biocontrol agent for boneseed (*Chrysanthemoides monilifera* spp. *monilifera*) in NZ in 2007. Significant effort went into mass-rearing the moth for widespread releases between 2007 and 2008, but establishment in the North Island was limited, and, after lots of unsuccessful searching, was deemed to have failed in the South Island. That is, until recently, when a population of the leafroller was discovered on the Port Hills of Christchurch in Canterbury.

Boneseed is a semi-woody shrub or small tree in the daisy family Asteraceae. In NZ, boneseed forms dense thickets, rapidly replacing low-growing native species in coastal areas, on sand dunes, cliffs, roadsides, margins of estuaries, and inshore habitats. It is a prolific seed producer (up to 50,000 per year per boneseed bush), with long-lived seeds easily spread by birds, possums, and possibly livestock. Seeds germinate readily after fire and ground disturbance. With boneseed having many of the characteristics of serious intractable weeds, biocontrol seemed a good and viable option.

In its native range of South Africa the boneseed leafroller has three generations per year, building up large numbers of caterpillars during summer, which can have a significant impact on their host plant. The moth gets its name from its leafrolling caterpillars, which construct feeding shelters at the tips of boneseed stems by webbing two or more neighbouring leaves together. The caterpillars eat the leaves and stems of boneseed from the safety of this shelter. Feeding by the caterpillars kills the shoot tips and terminal leaves, and mature caterpillars feed on leaves further down the stems, sometimes completely defoliating plants, resulting in reduced seed production and vigour, and sometimes death.

The leafroller was therefore seen as a very promising candidate for the biocontrol of boneseed. A similar number of generations was expected in NZ, with similar or even better damage levels as those observed in the native range. The majority of releases of the leafroller were made in the North Island in Northland and Auckland, although they were also released in Manawatū–Whanganui, the Greater Wellington region, and the Bay of Plenty. In the South Island the leafroller was released in Canterbury as well as further north in the Tasman region.

In November 2011, 4 years after the first releases of the moth took place, we reported that it was well established at three release sites in the North Island (in Northland and the Bay of Plenty) and that it had failed to establish at any of the South Island release sites. It was initially suggested that climate might be responsible for the total failure of the South Island releases, but overwintering experiments suggested this was not the cause. A field study then indicated that predation was limiting establishment of the leafroller. Some generalist parasitoids (at least four, both native and introduced) were already known to attack the eggs and caterpillars in NZ, and it was predicted that establishment would be unlikely in the presence of Argentine ants. However, the boneseed leafroller has outbreaks in its native range despite having plenty of natural enemies there. In some years populations manage to get ahead of the natural enemies, and it was hoped the same would happen in NZ.

Feeding damage by the leafroller. Inset: caterpillar

The field trial conducted in 2011 also revealed a link between the presence of scale insects on boneseed plants and failure of the moth to establish. The production of honeydew by scale insects attracts honeydew-feeding predatory insects such as wasps and ants. This would make the leafroller caterpillars very vulnerable to predation on plants infested with scale. In fact, establishment success was 70% at sites without scale insects, but zero at sites with high densities of scale. With these findings, no further effort was put into establishing the leafroller in areas where multiple releases had apparently failed.

"Fast forward 11 years, and I received a surprising email from a biosecurity officer, Abbie Roper, from Environment Canterbury in June to say she had found the boneseed leafroller on the Port Hills," said Ronny Groenteman, a senior researcher in the biocontrol team. "Not only did Abbie find the characteristic feeding damage of the leafroller caterpillars, but she found a culprit too," Ronny added.

After all these years it was very satisfying for all involved to know that the boneseed leafroller had established in the South Island after all. Sometimes it can take a long time for biocontrol agents to overcome establishment obstacles and build up to noticeable populations. Although we don't know whether this is a sign of better things to come, the outlook for biocontrol of boneseed is a lot more promising than it was a few months ago!

This project was funded by the National Biocontrol Collective.

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How Damaging is the Broom Gall Mite?

Scotch broom (*Cytisus scoparius*) was first recorded growing outside of cultivation in NZ in 1872 and has since spread throughout the South Island and lower North Island. Its range expansion has been most pronounced over the past 70 years, particularly very recently on the Central Plateau of the North Island. "The invasion of broom in and around Tongariro National Park (TNP) has been quite frightening," said Senior Technician Paul Peterson. "The flora in TNP is well adapted to low-fertility soils, and so it is particularly vulnerable to invasion by nitrogen-fixing plants such as broom," he added. Nitrogen-fixing plants have a symbiotic relationship with bacteria that convert or 'fix' nitrogen from the air, adding it to the soil in a form available to plants. This alters the soil chemistry to the detriment of some native ecosystems with organisms adapted to low-nutrient soils, such as in TNP. Thus, the demand for effective control measures for broom to preserve this ecosystem is high. The Department of Conservation is using chemical control methods to slow the invasion of TNP by broom from adjacent infested areas that are currently unmanaged, but this is costly, and probably not sustainable in the long term.

Enter the broom gall mite (*Aceria genistae*) which was first introduced into NZ for biocontrol of Scotch broom in 2008. The mite spread rapidly throughout the South Island and soon started to cause visible damage to large stands of broom. Mites feed on the sap of developing buds, which results in the formation of galls (a swelling or growth) instead of new branches or flowers. The galls also act as 'nutrient sinks', diverting resources that would otherwise have been invested in new growth. According to weed scientist Simon Fowler, the impact of the broom gall mite started to become apparent about 10 years after its introduction, clearly slowing plant growth rates and in some cases killing whole stands of broom.

Damage by the mite was particularly evident in the South Island, where it dispersed and became widespread very quickly. This presented an opportunity for Paul and colleagues to monitor the impact of the broom gall mite in the lower North Island, where the mites had been slower to establish and spread.

"We set up a field experiment to quantitatively measure the impact of the mites," explained Paul. "Our impact assessment studies initially involved the exclusion of mites from plants to compare their growth with plants exposed to attack by the agent. However, an attempt to protect broom plants from mite attack at a site in the South Island failed, so it was decided a new tack was needed," he added. Thereafter, a low maintenance study was set up by tagging 100 broom plants growing on the roadside between Palmerston North and TNP, and between Palmerston North and Hastings, in late 2016 and early 2017. Stem diameters of each plant were measured, and a mite release was randomly added to half of the plants, while the other half were left as controls (no mites were released onto them).

Dead broom from gall mite damage

During 2021 and 2022 final stem measurements of the tagged plants were taken. Unfortunately, due to roadside maintenance, slips, and spraying and cutting, only 34 of the original 100 tagged plants were still available for the final measurement. For the remaining plants, the results showed that plants that received a mite release were more likely to die and grew more slowly than broom plants that did not get a release of the gall mite. Nevertheless, the impact of the mite on plant survival and growth rate was lower than expected, possibly because some of the plants that received mite releases failed to produce galls. Also, some control plants were eventually colonised by mites from nearby plants, reducing our ability to quantify impacts on the experimental plants.

Interestingly, the plants that received mite releases but did not produce galls were still less likely to survive and had slower growth rates compared to the control plants. In the past, broom plants have been reported to look stressed or to have some of their branches die following a release of the mite, despite not producing any obvious galls. There are two possible explanations for this: the mites inflict damage to the plants before dying out, which facilitates secondary infections by pathogens; or the mites damage the plants and remain present, but the plants are resistant to producing galls.

Despite the variable and limited results from this study, it is clear the broom gall mite is reducing the growth rate and survival of Scotch broom in NZ. This is good news for regions of the South Island where broom is a significant weed, and for areas such as TNP, where uncontrolled invasion could quickly transform this ecosystem to the detriment of many native plant species specifically adapted to local conditions.

This project was funded by the Ministry of Business, Innovation and Employment as part of Manaaki Whenua – Landcare Research's Beating Weed Programme.

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Spring Activities

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

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)*

- Because 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)*

- We don't know if the gall wasp is successfully establishing in New Zealand, so we will be interested to hear about updates from release sites. 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.

Honshu 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.

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.

Moth plant beetle *(Freudeita cupripennis)*

- We think this beetle has established in the Bay of Plenty and the Waikato but it may still be at low densities due to a limited number of releases so far. Look for adult beetles on the foliage and stems of moth plant. The adults are about 10mm long with metallic orangey-red elytra (wings) and a black head, thorax and legs. The larvae feed on the roots of moth plant so you won't find them easily.
- 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 the beetle.

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 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 of the adult beetles and larvae on the stems and leaves of tradescantia. 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)*

- The smut fungus is now well established in many parts of the North Island. 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 moth *(Lathronympha strigana)*

- We don't yet know if the tutsan moth has established so are keen to hear if anyone can find them. 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:

Giant reed gall wasp

- boneseed leafroller (*Tortrix* s.l. sp. *chrysanthemoides*)
- broom gall mites (*Aceria genistae*)
- broom leaf beetle (*Gonioctena olivacea*)
- 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 to 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*) Shootmoth (*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 (*Macrorrhinia endonephele*)	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, beginning to cause extensive damage to broom at many sites, especially in the South Island (SI).
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, also recently reported 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 of the rust from Argentina to conduct more tests, only 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 confirmed in Southland.
Field horsetail weevil (*Grypus equiseti*)	Foliage and rhizome feeder, field releases began in 2017, establishment is looking likely, further releases planned.
Giant reed gall wasp (*Tetramesa romana*)	Stem galler, field releases began in late 2017, establishment confirmed at one release site near Auckland.
Giant reed scale (*Rhizaspidiotus donacis*)	Sap sucker, approved for release in 2017, first field releases made early in 2021, establishment likely at one site in Auckland, further releases planned.
Gorse colonial hard shoot moth (*Pempelia genistella*)	Foliage feeder, from limited releases widely 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 pytoptera*)	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, has damaged/killed 40,000+ ha heather at Tongariro National Park and Rotorua since 1996, spreading rapidly, uncertain if new strains more suited to high altitude released recently have established.
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, thought unlikely to have established.
Hieracium gall midge (*Macrolabis pilosellae*)	Gall former, established but spreading slowly in the SI, common near Waiouru, where it has reduced host by 18% over 6 years, very damaging in laboratory trials.
Hieracium gall wasp (*Aulacidea subterminalis*)	Gall former, established and spreading well in the SI but more slowly in the NI, appears to be having minimal impact although it reduced 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, thought unlikely to have established. 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, established and spreading slowly at sites in the Mackenzie District and North Canterbury, impact unknown, further releases planned. Foliage feeder, released at limited sites in late 2018, established at sites in North Canterbury and Marlborough, causing obvious damage already, further releases planned.
Honshu 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, rearing ongoing in preparation for more field releases, establishment confirmed at one site in Canterbury.
Lantana blister rust (*Puccinia lantanae*) **Lantana leaf rust** (*Prospodium tuberculatum*) **Lantana plume moth** (*Lantanophaga pusillidactyla*)	Leaf and stem rust fungus, releases began autumn 2015, does not appear to have established to date, and a further attempt will be made in 2021. 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 (*Freudeita cupripennis*) **Moth plant rust** (*Puccinia araujiae*)	Root and foliage feeder, field releases began in late 2019 and will be on-going, some promising early signs that establishment is likely. Rust fungus, approved for release in 2015 but not released yet as waiting for export permit to be granted.
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, stunts the new growth, approved for release in 2019, first field releases took place in 2021. Establishment confirmed in Canterbury and Manawatū–Whanganui. 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, establishment confirmed at this site.
Privet lace bug (*Leptoypha hospita*)	Sap sucker, releases began spring 2015, establishment confirmed in Auckland and Waikato, some promising early damage seen already in shaded sites.
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, recent study suggests it can have a significant impact on seed production.
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 at several sites in the NI.
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 but some promising signs seen. 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

Bownes A, Den Breeyen A, Ford K 2022. **Feasibility of biological control of purple loosestrife, *Lythrum salicaria*.** Envirolink Grant: 2223-HZLC165. Manaaki Whenua – Landcare Research Contract Report LC5031 for Horizons Regional Council.

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Paynter Q, McGrannachan CM 2021. **Populating data into a new prioritisation tool for National Biocontrol Collective funded work in New Zealand**. Envirolink Grant: 2106-HBRC258. Manaaki Whenua – Landcare Research Contract Report LC3936 for the National Biocontrol Collective.

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Probst C, McGrannachan C, Morton S, McGrath Z, White R, Cartier A 2022. **Invertebrates and fungi associated with Chilean flame creeper, *Tropaeolum speciosum* Poppp. & Endl., in New Zealand.** Manaaki Whenua – Landcare Research Contract Report LC4109 for the National Biocontrol Collective and the Ministry for Primary Industries.

Probst C, McGrannachan C, Morton S, McGrath Z, White R, Cartier A 2022. **Invertebrates and fungi associated with yellow flag iris, *Iris pseudacorus* L. in New Zealand**. Manaaki Whenua – Landcare Research Contract Report LC4111 for the National Biocontrol Collective and the Ministry for Primary Industries.

Viewing on work in the Pacific

Pacific Battler Lounge Event 'Weeds or Resilience: Restoring Natures' Services'. The full webinar is available: Pacific Battler Lounge Event | Weeds or Resilience: Restoring nature›s services - full webinar event - YouTube or the individual videos:

a. Introduction to weeds or resilience: Restoring nature's services

b. Natural enemies has been around for decades | Flashback

c. Impact of African tulip in the Cook Islands | Creature feature

d. Rarotonga uses natural enemies to increase climate resilience | Out & about

e. Simple, low-cost and effective containment facilities in Vanuatu | Gear tech review

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

Biocontrol Agents Released in 2021/2022

Species	Releases made
Honshu white admiral *(Limenitis glorifica)*	13
Moth plant beetle *(Freudeita cupripennis)*	3
Giant reed scale *(Rhizaspidiotus donacis)*	2
Giant reed gall wasp *(Tetramesa romana)*	2
Field horsetail weevil *(Grypus equiseti)*	6
Tradescantia yellow leaf spot *(Kordyana brasiliensis)*	8
Old man's beard mite *(Aceria vitalbae)*	14
Total	48