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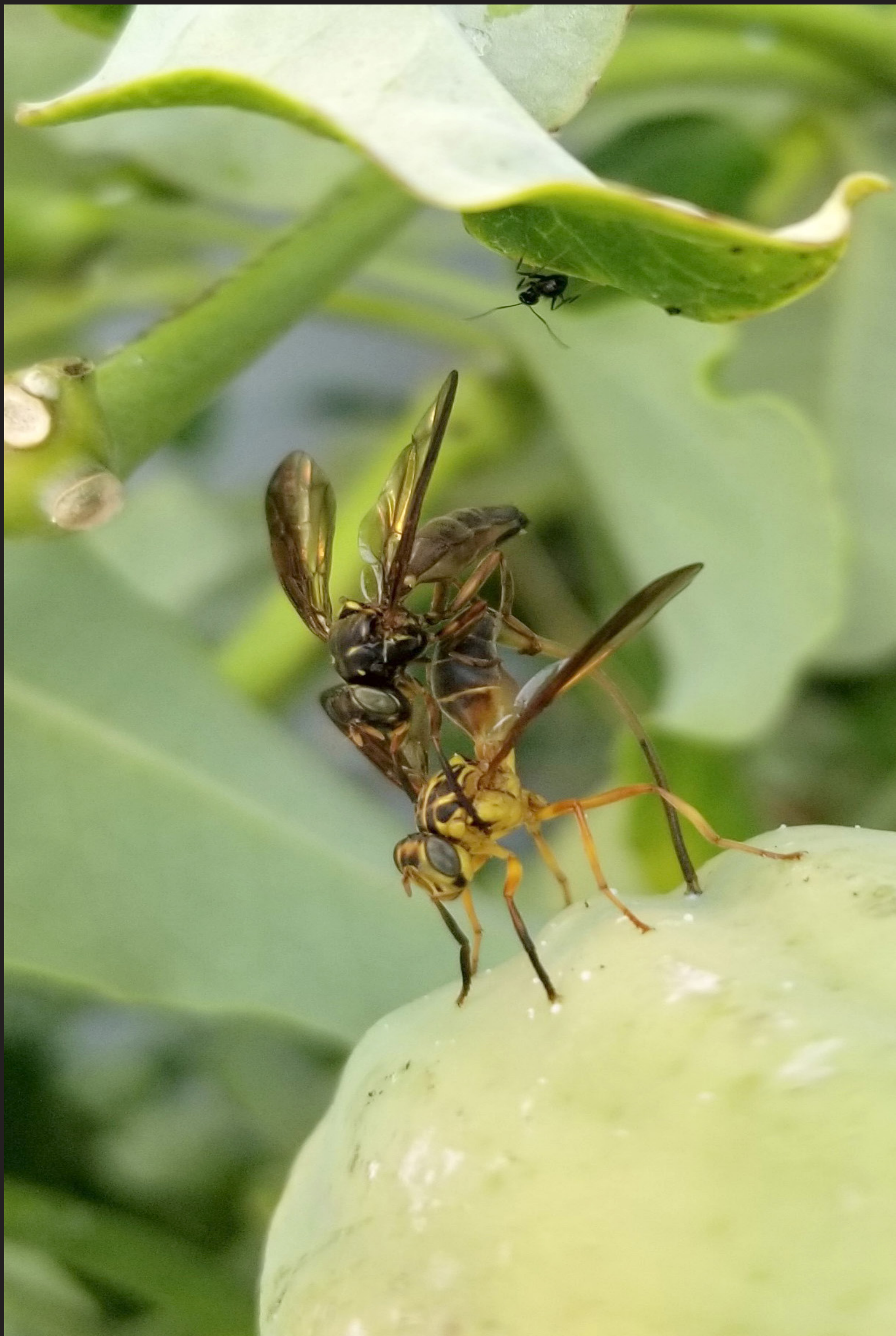
Manaaki Whenua
Landcare Research

Weed Biocontrol

WHAT'S NEW?



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COVER IMAGE:
Moth plant fly, *Anastrepha australis*

www.weedbusters.org.nz

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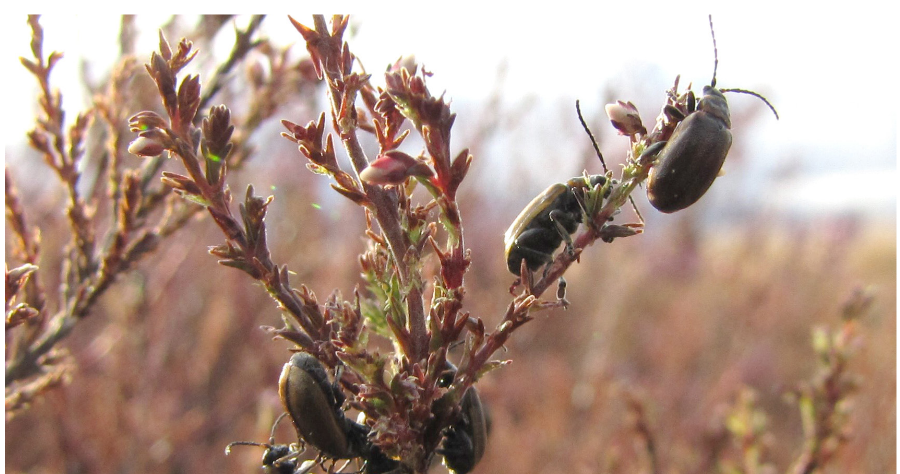
Biocontrol vs Herbicides – a Case Study on Heather

Invasive non-native/exotic species have become so abundant and widespread throughout the world that their management is a prerequisite for the protection of native biodiversity and ecosystem services. Effective control of a target invasive species while avoiding direct non-target effects is essential for invasive species management in natural ecosystems. However, the recovery of native species to achieve long-term ecosystem benefits following control is just as important as reducing the abundance of the target invader.

Herbicides are widely used to manage invasive weeds despite their low specificity and potential for non-target impacts on native biota. They may also slow the recovery of native plant communities. On the other hand, classical biocontrol of exotic weeds poses a very low risk of non-target impacts, provided host-range testing protocols are diligently applied. Both herbicide application and biocontrol are widely used for weed management in New Zealand, but studies on their long-term ecosystem impacts (for example, community responses following control) are seldom conducted.

To help remedy this, Paul Peterson and colleagues from Manaaki Whenua – Landcare Research, Open Polytechnic and Massey University conducted a direct comparison of the efficacy and non-target impacts of biocontrol and herbicides, as well as secondary invasion, using the invasive weed heather (*Calluna vulgaris*) as a case study. Heather is an evergreen, woody, perennial shrub, native to Europe, Asia and North Africa, which was intentionally introduced into Tongariro National Park (TNP) in the North Island in 1912. It subsequently became the most problematic exotic plant in the park, invading more than 50 000 hectares. These heather infestations displace native flora and alter invertebrate assemblages in the park. They also disrupt military operations in NZ Defence Force land.

A biocontrol programme for heather was initiated by the Department of Conservation in 1990, which led to the release of one agent, the heather beetle (*Lochmaea suturalis*), in TNP in 1996. The beetle was slow to establish, although beetle outbreaks that killed patches of heather became evident from 2001. These annual beetle outbreaks, described as "slow-dispersing feeding fronts", cause severe defoliation and die-back of heather. Around the same time, a dicot-selective herbicide (2,4-D ester) was being tested against heather in the adjacent Waiouru Military Training Area. 2,4-D ester was found to be highly effective at killing heather (90%), although non-target impacts from its use were predicted.



Heather beetles in Tongariro National Park

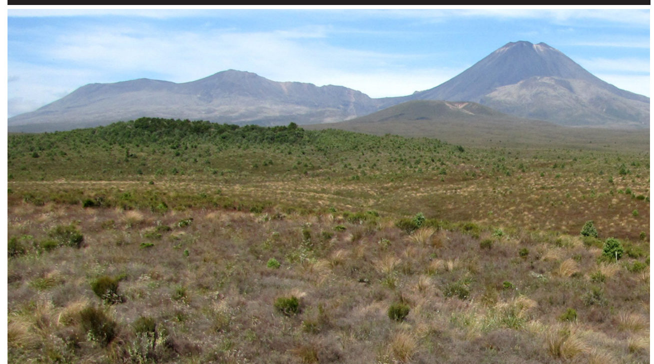
Damage caused by heather beetle outbreaks combined with the periodic application of 2,4-D ester for heather control provided an ideal opportunity to compare these two management strategies. A 5-year field trial initiated in 2007 measured the impacts of biocontrol and herbicides on heather and native flora, and monitored plant community responses. The randomised block design experiment with four treatments and six replicates included: (1) a biocontrol plot exposing heather plants to beetle herbivory; (2) a herbicide plot, treated with herbicide and an insecticide, to exclude beetle herbivory; (3) a biocontrol and herbicide plot with plants exposed to beetle herbivory and herbicide; and (4) a control plot, treated only with an insecticide to exclude the beetles. The herbicide and insecticide treatments were reapplied as necessary during the study period. Each February from 2008 to 2012 the percentage cover of all vascular and non-vascular (bryophytes, clubmosses and lichens) plants growing in the subplots was visually assessed.

"The results showed that biocontrol and herbicide were nearly equally effective at reducing heather cover," said Paul, who led the research project. "Biocontrol reduced heather cover by 97% and herbicides by 87%. This was in comparison to a 20% increase in heather when no control methods were applied," he added. Both control methods were effective at preventing a resurgence of the weed during the study period. "We also found no differences between the two control methods when we examined their impacts on monocots (grasses) at the site. Monocots, both native and exotic, increased in percentage cover and species richness following reductions in heather from biocontrol and herbicides," explained Paul.

The key difference between the two control methods became apparent when the researchers analysed the response of native dicots in the ecosystem. Native dicots, the most species-rich group, increased by 20% after five years following successful biocontrol. Exotic dicots also increased following biocontrol. In contrast, the dicot-selective herbicide had major non-target impacts on native (and exotic) dicots, significantly reducing their percentage cover and species richness. Consequently, secondary invasion by other exotic plant species after heather control was greatest after biocontrol due to the increase in exotic dicots, whereas the herbicide eliminated all dicot species. "Despite the fact that secondary invasion was greatest after biocontrol, the overall ecosystem benefits from biocontrol were still greater because of the recovery of native flora," explained Paul.

However, predicting long-term ecosystem recovery is difficult, and the persistence of secondary invaders may depend on several factors. The rapid die-back and removal of heather in this study system made space for other species to invade and exploit a flush of nitrogen into the system from decaying heather. Other research has shown that this type of scenario typically favours rapid-germinating, fast growing and nutrient-loving early colonisers. The native plant community in TNP and the WMTA is slow growing by contrast, having evolved

Heather in Tongariro National Park in 2000



Tongariro National Park in 2018

in nutrient-deficient volcanic soils and harsh environmental conditions. In light of this, the authors hypothesise that after the nutrient flush from decaying heather is exhausted, the exotic early colonisers will decline and be outcompeted by native species better adapted to the local conditions, resulting in increased resilience to further invasion.

This was one of only a few studies to experimentally compare the efficacy of biocontrol and herbicides in conjunction with quantifying non-target impacts and benefits to biodiversity after successful control. The study clearly demonstrated the safety and efficacy of biocontrol for the management of exotic weeds, and that biocontrol optimises ecosystem recovery compared to herbicides. An added advantage of biocontrol is that the agents persist and disperse, reaching other target weed infestations not actively managed.

Further reading: Peterson PG, Merrett MM, Fowler SV, Barrett DP, Paynter Q 2020. Comparing biocontrol and herbicide for managing an invasive non-native species: efficacy, non-target effects and secondary invasion. Journal of Applied Ecology. doi: 10.1111/1365-2664.13691

This project was funded by the Ministry of Business, Innovation and Employment's Strategic Science Investment Fund as part of Manaaki Whenua – Landcare Research's Beating Environmental Weeds Programme.

The Journal of Applied Ecology*'s October Editor's choice summary of the article is available at https://appliedecologistsblog.com/2020/10/01/editors-choice-5710*

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MISCCAP – a New Collaboration for the Pacific

A new project "Managing Invasive Species for Climate Change Adaptation in the Pacific", is underway to allow Pacific Island Countries and Territories (PICTS) to take stronger action against invasive species and thereby build resilience to climate change. Invasive species make ecosystems and communities more vulnerable to natural disasters and the impacts of climate change. They increase erosion, reduce food and fish production, and pose critical threats to ecosystem services and human health. Invasive species will become more widespread as disturbances, carbon dioxide levels in the atmosphere, and temperatures all increase under climate change.

New Zealand's Ministry of Foreign Affairs and Trade (MFAT) is partnering with the Secretariat of the Pacific Regional Environment Programme (SPREP), Manaaki Whenua – Landcare Research, and the Department of Conservation (DOC) in this endeavour. MFAT funding will support the newly established Pacific Regional Invasive Species Management Support Service (PRISMSS), which is hosted by SPREP, and allow Manaaki Whenua and DOC to contribute their expertise.

PRISMSS remains a service available to the whole Pacific, but this new project will focus initially on the Cook Islands, Niue, Republic of the Marshall Islands, Tonga, Tuvalu, and Vanuatu. The involvement of other PICTs will also be explored. This project is designed to be complementary to other invasive species projects underway, funded by other donors such as GEF-6. Other agencies, such as Island Conservation, Birdlife International Pacific, Pacific Biosecurity, and the Pacific Community are also involved with PRISMSS.

SPREP is the region's key intergovernmental organisation for the environment and sustainable development, and is owned and governed by 21 PICTS and five 'metropolitan' members, including New Zealand. The SPREP Invasive Species Team's primary objective is to "significantly reduce the socio-economic and ecological impact of invasive species on land and water ecosystems and control or eradicate priority species" in the Pacific region. "A major gap is the implementation of management action for invasive species," said David Moverley of SPREP. PRISMSS is the mechanism designed to address this. This project will help SPREP to:

- establish PRISMSS and the systems required to scale up invasive species management
- implement key actions to support PRISMSS programmes
- strengthen the enabling environment and mainstream invasive species management across the Pacific.

The project will also extend Manaaki Whenua's Natural Enemies – Natural Solutions (NENS) programme, allowing more invasive weeds to be tackled. "Weeds are particularly problematic because they threaten all terrestrial and freshwater ecosystems in the Pacific, and because of the sheer number of them to manage," said Lynley Hayes, who leads the NENS programme. Weeds thrive on disturbance and are often the first species to recover after storms and cyclones, which also spread them to previously uninvaded areas.

The only feasible method for managing widespread weeds is through the use of their natural enemies, which has a long history (over 100 years) of being safely and successfully used in the Pacific. However, in recent decades this has become a forgotten or under-utilised tool in most PICTs. The new project will allow this management approach to once again be more widely utilised through:

- training people in NENS and developing the infrastructure and set-ups to conduct the work
- developing better information about NENS opportunities available to PICTs, and determining the top priorities
- supporting collaboration through the sharing of lessons, stories, expertise, and natural enemies already present in the Pacific
- creating new solutions by researching natural enemy options for serious emerging weed threats not studied to date.

"DOC's involvement will build on its long commitment to sharing its internationally recognised expertise in predator control, invasive species management and threatened species relocation and restoration with PICTs," said Jonathan Rudge of DOC. Specifically, DOC will assist by:

- providing specialist support, technical assistance, advice and training on invasive species management
- supporting the implementation of priority management actions and regional work programmes, especially Predator Free Pacific and Resilient Ecosystems-Resilient Communities
- providing direct operational support for high-priority in-country projects
- assisting with awareness raising and research activities.

It is expected that the new partnerships and opportunities created by this project will play a meaningful role in improving the quality of life for many people whose wellbeing and security are closely tied to the health of their ecosystems.

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Department of Conservation Te Papa Atawhai
Manaaki Whenua Landcare Research
PRISMSS
NEW ZEALAND FOREIGN AFFAIRS & TRADE Manatū Aorere

Biocontrol for Singapore Daisy in the Pacific?

Native to tropical America and parts of the Caribbean, Singapore daisy (*Sphagneticola trilobata*) has been introduced to the Pacific, North America, Europe, Africa, Asia and Australia, but fortunately not to New Zealand. Since its arrival in Hawaii in 1965, Singapore daisy has spread throughout most of the Pacific region to become a significant and dominant plant invader within the region. It is considered invasive in at least 19 Pacific Island countries and territories and is present in an additional three. Singapore daisy is included on the International Union for Conservation of Nature's list of the 100 World's Worst Invasive Species due to its severe environmental and ecological impacts. These include smothering and shading native plant species, reducing regeneration of natives from the soil seedbank, impeding the growth of shrubs and trees by exuding allelopathic residues, and reducing the genetic viability of native species through hybridisation. Because of this weed's significant threat to island ecosystems, it is one of the potential new biocontrol targets being explored under MISCCAP (see facing page). As usual, the first step has been to conduct a feasibility study.

Singapore daisy was once favoured as a garden and landscaping ornamental, and this has significantly contributed to its distribution within the Pacific region and other parts of its introduced range. Despite its recognition as a significant invader, there is very little legislation on its pest status in the Pacific. This species forms large, dense rhizome mats that can reduce biodiversity and may threaten locally endangered medicinal plants. It is tolerant of a range of environmental conditions, including high salinity, drought, extended flooding, shade, and a variety of pH levels. This adaptability to different conditions means Singapore daisy may have a range of socioeconomic impacts, including food insecurity and loss of income from reduced crop production. The spread of Singapore daisy may be exacerbated by climate change, deepening livelihoods impacts on Pacific peoples. Singapore daisy can reproduce vegetatively from stem fragments and sexually, with seeds becoming dominant in the seed bank. The transport of vegetative parts and the disturbance or transport of soil containing seeds are notable means by which this species is dispersed.

Physical and chemical control methods have been used for combating Singapore daisy, but they are seldom effective in managing large infestations. Furthermore, both control methods are time and labour intensive and expensive. Control efforts are often futile, as stem fragments can easily take root if not completely removed or destroyed. The costs associated with unsuccessful control campaigns can be extremely high. For example, a control campaign initiated in Niue in 2001 attempted to eradicate Singapore daisy from 35 sites in 11 villages, at a cost of approximately $30,000. However, the programme was unsuccessful as the weed was later found in an additional 52 sites in 13 villages. The ineffectiveness of physical and chemical control methods leaves biocontrol as the only viable option.

Singapore daisy invading pasture in Tonga

"Singapore daisy has not been targeted for biocontrol before, and there has been very little research on the natural enemies associated with this weed species in both its native and introduced ranges," said Chris McGrannachan, who led the feasibility study. Chris and Chantal Probst have identified in the literature six arthropods that feed on the weed and 14 fungal species associated with it. Of all the species identified, only one fungus (*Endophyllum wedeliae*) from Jamaica, is considered a promising candidate biocontrol agent. Jamaica is an ideal place to conduct initial surveys as Manaaki Whenua has established connections with the University of West Indies, which has assisted with surveying potential biocontrol agents for other Pacific weeds as recently as November 2019. However, given that no targeted surveys of natural enemies associated with Singapore daisy have been conducted, more widespread surveys throughout its native distribution range will most likely be necessary. This will maximise the chances of locating host-specific natural enemies that can be considered for biocontrol of Singapore daisy. If successful, biocontrol of Singapore daisy in the Pacific region will help to curb biodiversity loss and protect natural ecosystems that are threatened by this prolific invader.

This project is funded by the Ministry of Foreign Affairs and Trade.

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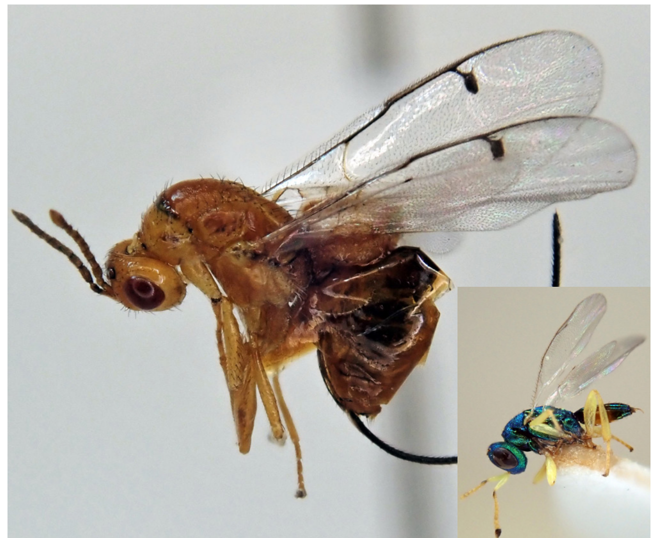
Douglas Fir Evades Biocontrol Due to Parasitism

Douglas fir (*Pseudotsuga menzisii*) is a large, evergreen conifer native to the cooler regions of western North America. Douglas fir has been planted extensively in New Zealand for timber production, and several seed orchards have been established. Like many other conifer species worldwide, Douglas fir escaped cultivation and has become a serious invasive species in New Zealand's high country landscapes and fragile native ecosystems, such as tussocklands and herbfields. Douglas fir's tolerance of partially shaded environments has also enabled it to establish in native forests and forest margin communities.

In the 1920s a small wasp, the Douglas fir seed chalcid (DFSC) (*Megastigmus spermotrophus*), which destroys the seeds of Douglas fir, was accidentally introduced into New Zealand in imported seed. The females lay eggs in the seeds in immature cones and the larvae feed and develop inside the seeds, which eventually drop to the ground for the larvae to overwinter and then pupate (inside the seeds). Due to concerns over the DFSC's impact on Douglas fir seed production, an ectoparasitic wasp (*Mesopolobus spermotrophus*) was intentionally released as a biocontrol agent for the DFSC in 1955. This parasitoid is reportedly host specific to the DFSC and attacks host larvae in mature cones that have opened enough to allow females access to the seeds to lay their eggs. The females only lay eggs on seeds in cones that are still attached to the tree, and they will not target those that have already dropped to the ground. Since the release of the parasitoid, sporadic and opportunistic surveys of Douglas fir seeds did not recover any parasitoids, so the biocontrol agent was presumed to have failed to establish.



DFSC adult DFSC parasitoid

Douglas fir is not the only conifer species in New Zealand to have escaped forestry plantations to become a serious invader. 'Wilding conifers' (or 'wilding pines') is a New Zealand term for introduced conifers that are spreading across the landscape at an alarming rate, with estimates that 20% of New Zealand will be covered by wilding conifers within 20 years without appropriate management interventions. "With the control of wilding conifers now a high priority for New Zealand, we are very interested in the potential for seed-attacking agents to reduce the spread of Douglas fir," said Simon Fowler, who is leading research on biocontrol options for wilding conifers. This also formed part of a larger study aimed at documenting the success and failure of all weed biocontrol agents that have been released in New Zealand.

A student intern from the University of Birmingham, Sonia Lee, has assisted with investigations of the impact of DFSC on Douglas fir seed production. In the 2019/20 summer Douglas fir cones were collected at 13 sites throughout New Zealand (three in the North Island, 10 in the South Island). Back at the laboratory over 21,000 seeds were removed from the cones and placed in Petri dishes to monitor insect emergence. Once emergence appeared to be complete, Sonia meticulously dissected all the harvested seeds to look for larvae that were still in a state of suspended development (diapause). In total, 17 DFSC adults and larvae were recovered from Douglas fir seeds collected from all 13 sites, which equates to an extremely low rate of attack on the seeds (0 to 0.85% per site).

"This low rate of seed attack, much lower than the average of 20% seed destruction reported in the 1970s, was very disappointing," said Simon. "But we soon had an explanation. Much to our surprise, Sonia recovered the parasitoid released for biocontrol of the DFSC, recording a parasitism rate of 48.5%," he added. The identity of the parasitoid wasp was confirmed by morphological examination and a molecular analysis, and the results sent to the Ministry for Primary Industries to officially accept and document its presence in New Zealand. Although this is the first record of the parasitoid in New Zealand, Simon considers it unlikely that a population of the wasp remained undetected for almost 70 years since its first release. "It is more likely that an accidental incursion occurred much later than the 1950s, with the importation of seed infested with DFSC and its parasitoid. Large amounts of Douglas fir seed were imported into New Zealand for genetic improvement in the 1980s so it may have established then," explained Simon.

With the high parasitism rate of the DFSC recorded in this study, it is plausible that this seed-attacking wasp is itself under successful biocontrol in New Zealand. Unfortunately, as a result, Douglas fir has evaded a potential biocontrol agent that held promise for reducing its invasiveness and spread here.

This project was funded by the Ministry of Business, Innovation and Employment (Winning Against Wildings programme and core research funds to Manaaki Whenua – Landcare Research).

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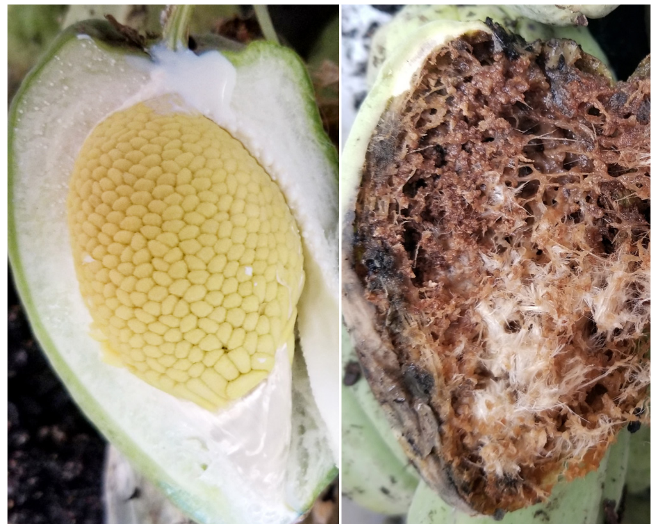
A Seed-Damaging Fly for Moth Plant?

A fly (*Anastrepha australis*, previously *Toxotrypana australis*) that feeds and develops inside the fruit pods of moth plant (*Araujia hortorum*), completely destroying the seeds, is currently undergoing host range testing at our Tamaki containment facility in Auckland. The fly is the third candidate biocontrol agent for moth plant to be tested in New Zealand. A rust that infects the leaves and stems of moth plant was approved by the Environmental Protection Authority in 2015, but its release is pending the issue of an export permit from Argentina. The moth plant beetle (*Freudeita cupripennis*), which feeds on the roots (larvae) and leaves (adults) of moth plant, was first released in December 2019 in Northland and the Bay of Plenty, and in February this year in the Waikato region.

Moth plant is an evergreen vine/climber originating from southeast Brazil, Argentina, Paraguay and Uruguay. Moth plant was introduced to New Zealand as an ornamental, and it is now a common weed in urban and peri-urban environments in northern New Zealand. It also invades intact and disturbed forest and forest margins, coastline, cliffs, riparian margins, shrublands and mangroves. The twining vines smother and break down shrubs and small trees, and they spread along the ground, shading out seedlings and low-growing vegetation. Although only a small percentage of flowers bear fruit in New Zealand, presumably due to a lack of suitable pollinators, moth plant's large fruits produce 250 to 1,000 parachute-like seeds, which are easily dispersed by wind. What's more, the seeds can remain viable for more than 5 years. A biocontrol agent that destroys the wind-dispersed seeds would help to contain moth plant populations, preventing further spread.

The moth plant fly can be found throughout the native distribution range of moth plant. There are different colour morphs within the species, which have required genetic testing to confirm their identity as one species. Most adults are brown with black markings, but some are yellow and black, having a distinct wasp-like appearance. In Uruguay, adults are active from late November/early December through to February. Females lay six to ten eggs in developing pods, although higher numbers of larvae per pod have been recorded. Females have a long ovipositor (almost the entire length of their body), with a needle-like protrusion at the tip, perfectly adapted for penetrating the thick, spongy wall of the fruit pods. Larvae feed on the seeds, turning the inside of pods to mush, only exiting the pods when they are ready to pupate in the soil.

The moth plant fly has been collected in Uruguay a number of times between 2010 and 2018, but laboratory rearing was initially unsuccessful due to limited numbers imported and asynchronous adult emergence in containment. "We also suspected that the fruit pods were not of high [enough] quality for rearing the fly, so we needed to improve our plant



Undamaged fruit pod (left) and damaged fruit pod from larval feeding (right)

propagation techniques before reimporting another colony," said Zane McGrath, the technician on the project. Another trip to Uruguay to collect the fly was undertaken by Zane and Angela Bownes from late January to early February this year. "Although we had a reasonable idea of the best time to survey for the fly, we had a little bit of luck on our side too," explained Zane. "The fly larvae that we collected were all of the same age (cohort) and all were collected over three consecutive days in the north-eastern suburbs of Montevideo, despite surveying for 10 days in the outskirts of the city and further afield. If we had gone a week later, we would have turned up empty pods," he added.

The mature fly larvae exited the moth plant pods within a few days after they were collected, and over 80 pupae were imported into containment. So far, rearing of the new colony has been successful, and host range tests have been conducted on swan plant (*Gomphocarpus fruiticosus*). "The females showed no interest in swan plant for oviposition, which is very encouraging," said Zane. Although swan plant is not native to New Zealand, it is the main host plant of beloved monarch butterflies in New Zealand. "Further testing will be done this summer with a view to a release application being submitted to the EPA in 2021, should the fly prove to be sufficiently host specific," concluded Zane. In the meantime, the moth plant beetle is performing well with recent reports of the recovery of adult beetles at the original release sites. This means the beetles successfully completed at least two generations in the field and survived their first winter in both Northland and the Waikato. Now that's a beetle to be proud of!

This project is funded by the National Biocontrol Collective.

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Summer Activities

Summer is a busy time for many biocontrol agents, so you might need to schedule the following activities.

Broom gall mites *(Aceria genistae)*

- Check for galls, which look like deformed lumps and range in size from 5 to 30 mm across. Very heavy galling, leading to the death of bushes, has been observed at some sites.
- Harvesting of galls is best undertaken from late spring to early summer, when predatory mites are less abundant. Aim to shift at least 50 galls to each site and tie them on to plants so the tiny mites can move across.

Giant reed gall wasp *(Tetramesa romana)*

- Check release sites 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.

Green thistle beetles *(Cassida rubiginosa)*

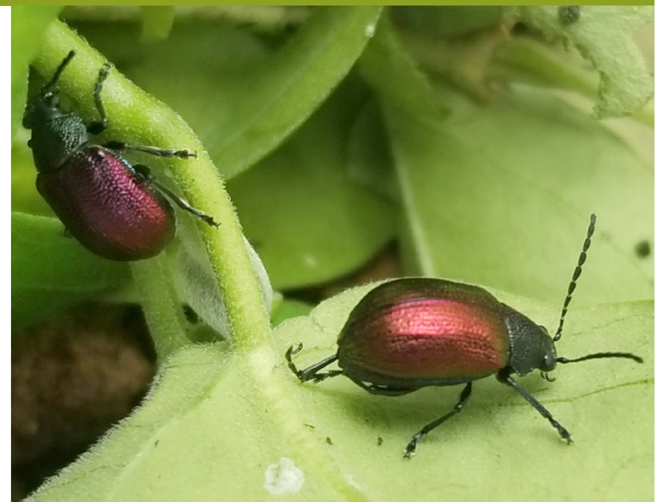
- December is often when green thistle beetle activity is at its peak. Look for adult beetles, which are 6–7.5 mm long and green, so they are well camouflaged. Both the adults and the larvae make windows in the leaves. Larvae have a protective covering of old moulted skins and excrement. You may also see brownish clusters of eggs on the undersides of leaves.
- If you find good numbers, use a garden leaf vacuum machine to shift at least 100 adults to new sites. Be careful to separate the beetles from other material collected, which may include pasture pests. Please let us know if you discover an outbreak of these beetles.

Honshu white admiral *(Limentitis glorifica)*

- Look for the adult butterflies 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.

Tradescantia yellow leaf spot *(Kordyana brasiliensis)*

- Look for the distinctive yellow spots on the upper surface of the leaves with corresponding white spots underneath, especially after wet, humid weather.
- The fungus is likely to disperse readily via spores on air currents. If human-assisted distribution is necessary, 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.



Adult moth plant beetles

Tutsan beetle *(Chrysolina abchasica)*

- 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 undersides of the leaves. They turn bright green just before they pupate.
- It will be too soon to consider harvesting and redistribution if you do find the beetles.

Tutsan moth *(Lathronympha strigana)*

- 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.
- It will be too soon to consider harvesting and redistribution if you do find the moths.

National Assessment Protocol

For those taking part in the National Assessment Protocol, summer 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

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Target	When	Agents
Broom	Dec–April	Gall mite *(Aceria genistae)*
Privet	Feb–April	Lace bug *(Leptoypha hospita)*
Tradescantia	Nov–April	Leaf beetle *(Neolema ogloblini)* Stem beetle *(Lema basicostata)* Tip beetle *(Neolema abbreviata)*
	Anytime	Yellow leaf spot fungus *(Kordyana Kordyana brasiliensis)*
Woolly nightshade	Feb–April	Lace bug *(Gargaphia decoris)*