What's New In Biological Control Of Weeds?

What's Inside:

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Don't Cry for Moth Plant in Argentina

South America is a popular place for Landcare Research staff to visit at present, as a number of the weeds we are currently battling hail from this continent. Nick Waipara and Jane Barton have recently been to Argentina. Nick's latest excursion was to progress our moth plant (*Araujia*) project. To find out what Jane was up to see *Grass Agents Slow to Reveal Their Secrets* (page 4).

Landcare Research is collaborating with the Universidad Nacional del Sur (National University) of Bahia Blanca and the Natural History Museum of La Plata to undertake surveys for potential biocontrol agents for moth plant. This was the first time Nick had met our collaborators Dr Carlos Villamil (botanist and project leader for the Argentinean work), Dr Rolf Delhey (plant pathologist) and Dr Diego Carpintero (entomologist) and their respective teams.

The trip began in Bahia Blanca, the most southern city of Buenos Aires Province, which is also the southern-most limit for moth plant in its homeland. Carlos, Rolf and Nick undertook a foray through the pampas grasslands of the province. "These grasslands are naturally treeless so moth plant has to make do with scrambling over low shrubs, fences and pampas grass (*Cortaderia* spp.) Further north a small native scrubby tree called tala (*Celtis tala*) is prominent in the more natural areas of the landscape and moth plant is able to climb up these trees," explained Nick.

A natural enemy of moth plant, Oncopeltus stali, *swarming on a maturing fruit in Argentina.*

Carlos and his team have undertaken botanical surveys of the four *Araujia* species (*A. hortorum, A. sericifera, A. angustifolia* and *A. megapotamica*) in Argentina. Closer examination of the flower morphology has revealed moth plant in New Zealand is probably the same species as the Argentinean *A. hortorum* rather than *A. sericifera* as it is currently known. Biogeography and climate data also support Carlos's morphology work, as their *A. hortorum* occurs at the same temperate latitudes in Argentina as moth plant in New Zealand, while *A. sericifera* only grows in the tropical part of northern Argentina (near Iguaçu Falls) and is not found in the cooler southern parts where *A. hortorum* grows. Carlos plans to publish these findings so that the proposed name change can be made official.

It quickly became apparent to Nick that, in contrast to New Zealand where the weed is remarkably free of insect and disease damage (see *Not Much Menacing Moth Plant*, Issue 30), moth plant in its homeland is seriously challenged by its natural enemies. "More than 90% of moth plant populations are infected by several diseases that cause widespread leaf, stem, flower and sometimes even fruit damage," enthused Nick. The most widespread disease, which was seen attacking most moth plant populations, was a leaf spot fungus that is a species of *Pseudocercospora*. It causes angular leaf lesions that are yellow on the top of the leaf with patches of black sporulation on the underside of the leaf (see photo). Rolf will work to identify this fungus to species level and test its pathogenicity.

The distinctive symptoms of Araujia mosaic virus (AjMV) were frequently seen and nearly always associated with swarms of its vector, the oleander aphid (*Aphis nerii*), on or nearby infected plants. Similar symptoms have been observed on a single plant near Auckland, but the causative agent has not yet been identified (see *Scaling Down an Unwanted Climber* Issue 32). Some impressive dieback has been seen near La Plata, where whole plants were killed, and is likely to be caused by a different, and as yet unidentified, plant virus.

The trio continued north through pasturelands along the coastline to the state capital La Plata, where Diego is based at an impressive and historic museum, which houses a large insect collection supported by 40 staff! During their foray they managed to collect a range of insects that were either feeding on moth plant or associated with damage. "The most impressive insect damage was seen at three locations where something was completely destroying the pods and causing premature splitting so the seeds aren't viable," revealed Nick. The most widespread insect collected on this trip was identified by Diego as *Oncopeltus stali* (see photo). This very striking orange and black insect swarms on the leaves, flowers and fruit, sucking the latex sap and so may also vector some of the viral pathogens observed.

Between La Plata and Buenos Aires the team discovered two severe outbreaks of rust pathogens. The first sighting was most impressive as almost 100% of leaves were infected and showing damage. At the second site plants were attacked by a rust that was causing galling and appeared to be associated with dieback of whole vine branches. This was a remarkable find for Rolf, being the first time such damage has been observed. The two rust outbreaks may have been helped by wet humid weather after a particularly long dry spring and summer. Rolf is now working to identify these rusts.

"It is really exciting to have so many good potential agents to choose from," concluded Nick, "and we should have a real chance of doing some serious damage to moth plant in New Zealand." Efforts will now concentrate on identifying and assessing the biocontrol potential of the natural enemies of moth plant that appear to show the most promise.

This project is funded by the national collective of regional councils and the Department of Conservation.

Symptoms of the common fungal leaf pathogen Pseudocercospora.

Alligator Weed Agents Dip Out

Quentin Paynter, fresh from a council of war in Australia about alligator weed (*Alternanthera philoxeroides*), has broken the bad news that the two potential new agents CSIRO has been testing have failed specificity tests. We had hoped the thrips (*Amynothrips andersoni*) and flea beetle (*Disonycha argentinensis*) might be able to add pressure to the plant in situations where the alligator weed beetle (*Agasicles hygrophila*) and alligator weed moth (*Arcola malloi*) are not able to provide sufficient control. However, the two insects were able to attack, and even complete their life cycles, on two species endemic to Australia: *Alternanthera sessilis* and *A. denticulata*. The thrips was also able to attack a native Australian plant, *Ptilotus polystachyus*. The flea beetle was released in both countries in the 1980s, when host specificity testing was less rigorous, but failed to establish. The reasons why they disappeared without a trace are unknown, but as it turns out it was probably for the best!

"The Australians have now washed their hands of these two agents and are focusing on other potential candidates," reported Quent. The results probably mean we will have to discard these two insects too, although the significance for us of possible damage to *A. sessilis* and *A. denticulata* is not quite as clear cut. *A. denticulata* is a widespread, but sparse, species of wetlands and damp ground around the top of the North Island. The jury is out as to whether it has arrived naturally (its fruit are suited to avian dispersal) from Australia and is part of our indigenous flora, or whether it is a human-assisted introduction that has naturalised, or both. *A. denticulata* is commonly confused with the more common *A. sessilis,* which can be found throughout the North Island and also in Canterbury. Although *A. sessilis* was previously considered to be an exotic species in New Zealand, recent research has indicated it may be native to New Zealand after all.

Galled tip caused by the fly Clinodiplosis altherantherae.

"Obviously it would be better to find agents that would not attack these plants than to try to argue that some damage to them might be acceptable in order to control alligator weed," explained Quentin. Fortunately other potential agents have been identified in the plant's native range of South America, but they have been much less well studied. A tip-galling fly (*Clinodiplosis alternantherae*) looks to be the next best prospect and our Australian colleagues are hoping to gain permission to be able to import it for testing soon. Our colleagues are also applying for funding to keep the project going for another 3 years beyond this November. Other potential agents that might be explored further include a leaf miner (*Ophiomya alternantherae*) with another flea beetle (*Phenrica* sp.).

Plant pathologists in Australia are also exploring the potential of a mycoherbicide approach to controlling the plant, using a pathogen that also occurs naturally here (*Nimbya alternantherae*), so we will be following progress with this line of research with interest.

Chris collecting A. sessilis *at Lake Waiporohita in the Far North as part of our non-target surveys.*

A national collective of regional councils and the Department of Conservation are making a contribution to the Australian alligator weed project to ensure plants of interest to New Zealand are included in any trials.

Grass Agents Slow to Reveal Their Secrets

Grasses have not traditionally been targets for biological control because the prevailing wisdom was that it would be too tricky to find agents that would not also attack desirable closely related species. However, the inadequacy of other control options has prompted some to take another look at biocontrol, and we have in recent times been lending some support to an Australian-led project against invasive *Nassella* species. From day one it has proved to be an uphill battle for a whole host of reasons (see *Tussling with Tussocks on Their Home Turf*, Issue 31). Efforts are currently focused on Chilean needle grass (CNG, *Nassella neesiana*) because it appeared to be an easier target to cut our teeth on than nassella tussock (*N. trichotoma*), but it is still proving to be no pushover! Three rust fungi have been identified that cause significant damage to CNG in its home range in Argentina: *Puccinia nassellae, P. graminella* and *Uromyces pencanus*. Unfortunately, recent work with these pathogens has shown they are almost as uncooperative as the nassella tussock fungi that were studied first.

"You would think we could coax just one of these rusts to complete its life cycle in the glasshouse," sighed Freda Anderson, who is working in Argentina for the Cooperative Research Centre for Australian Weed Management to try and crack these agents. It is important to know the full life cycle of a rust because some species have more than one host. That is, they form some types of spore on a "main" host and other types of spore on an "alternate" host (see diagram). CNG is the main host for the three rusts Freda is working on, and if any of them have an alternate host, we know from experience it will probably be a dicotyledonous plant. If a rust has an alternate host then it, and its close relatives, need to be included in host-range testing. Otherwise, if those plants grow in Australia or New Zealand, the rust could potentially damage them after release.

In January we sent plant pathologist, Jane Barton, on a second visit to Argentina to help Freda sort out what makes these pathogens tick. To date both *P. nassellae* and *U. pencanus* have refused to produce one spore type (aeciospores) on CNG in the glasshouse. There are two possible explanations for this. Firstly the fungi may have lost their ability to produce this spore type altogether; or secondly they may only produce them on an unknown alternate host. "So far, our experimental results and field observations suggest *U. pencanus* fits the first scenario," confided Jane, "but we still don't know which one is most likely to be true for *P. nassellae*." Since *U. pencanus* probably has only one host, it currently seems the more promising of the two as a biocontrol agent.

Indeed, *U. pencanus* seems to have quite good potential for biocontrol of CNG in Australia. Freda applied several strains of this rust to CNG seedlings grown from seed collected from Australia, and found one strain could successfully damage plants from six out of seven Australian populations, and did not infect two species of native Australian grasses. Unfortunately for us, however, none of the *U. pencanus* strains tested to date have been able to infect CNG plants sourced from two sites in New Zealand (Western Springs and Hawke's Bay). Another strain is being tested against New Zealand material right now. If this is also unsuccessful then further efforts will need to be made to find a strain of this rust that can infect New Zealand material. "This will be quite a large task," admitted Jane, "since we have no idea where in South America the New Zealand CNG material originated from, we don't know where best to look."

Freda and Jane thought they would be able to persuade the third rust, *P. graminella*, to complete its life cycle in the glasshouse because it has a simpler life cycle (no urediniospores or spermatia), and because it produces the other three types of spores readily on CNG the field. "So far I've been able to produce teliospores from aeciospores on CNG, but not vice versa," said Freda wistfully, "but I haven't given up!" At least the presence of aeciospores proves this rust doesn't have an alternate host. From the literature, *P. graminella* appears to be less host specific than *U.*

Freda Anderson in the glasshouse with her grasses at CERZOS, Bahía Blanca, Argentina.

Spore Types Potentially Formed by a Rust with a Full Life Cycle.

Teliospores (on main host, dark brown, long-lived, often dormant in harsh conditions)

↓

Basidiospores (on main host, sometimes infect alternate host, transparent, short-lived)

↓

Spermatia (often on alternate host, transparent, very tiny, very short lived)

↓

Aeciospores (often on alternate host, infect main host, yellow or orange, moderately short lived)

↓

Urediniospores (on main host, stage can be repetitive: urediniospores urediniospores, orange/rust-coloured, moderately long lived)

pencanus. It has been reported infecting grasses from the genus *Piptochaetium* (which is closely related to *Nassella*) as well as from several different *Nassella* species. This could be a good thing as it suggests the rust may be able to infect CNG plants from all Australian and New Zealand populations.

This hypothesis will be tested as soon as another obstacle, the absence of urediniospores, can be overcome. Urediniospores are the rust-coloured spores most rusts use as their dispersal stage and this is the spore type typically used for testing and for making releases. They are usually produced in abundance because infection by one urediniospore can lead directly to the production of many more. While urediniospores can only be produced on living plant material, they can usually be stored in a refrigerator for some time until needed. However, since *P. graminella* does not produce urediniospores Freda has to work with aeciospores, which don't survive storage for more than a couple of weeks. "I need to find an easy way of producing teliospores from aeciospores and vice versa," explained Freda.

As we well know Aussies don't quit just because the going gets tough, and David McLaren (CRC for Australian Weed Management) has applied for three more years of funding for *Nassella* biocontrol.

If his application is successful, then the next step will be full host-range testing of *U. pencanus*. In preparation for this work Freda has started looking at the best way to apply the rust to test plants; the best conditions for infection, and, methods to observe the rust–plant interaction under the microscope. While we won't benefit directly from this work, the results will be useful if a strain of *U. pencanus* that can infect CNG plants from New Zealand can be found. After host-range testing of *U. pencanus* has finished, host-range testing of *P. graminella* will begin, but only if Freda can find a way of "bulking up" the rust. It seems our tussles with tussocks are still far from over!

The New Zealand contribution to this project is funded by a national collective of regional councils and the Department of Conservation. Jane Barton is a contractor to Landcare Research.

Uromyces pencanus *on Chilean needle grass in the field in Argentina.*

Our Gaggle of Gorse Agents

We have been working on gorse biocontrol in New Zealand now, in fits and starts, for more than 70 years and have released no fewer than seven insect agents. In this piece we give you a rundown on the current state of play and consider what still needs to happen if we are ever to tame this persistent prickly pest.

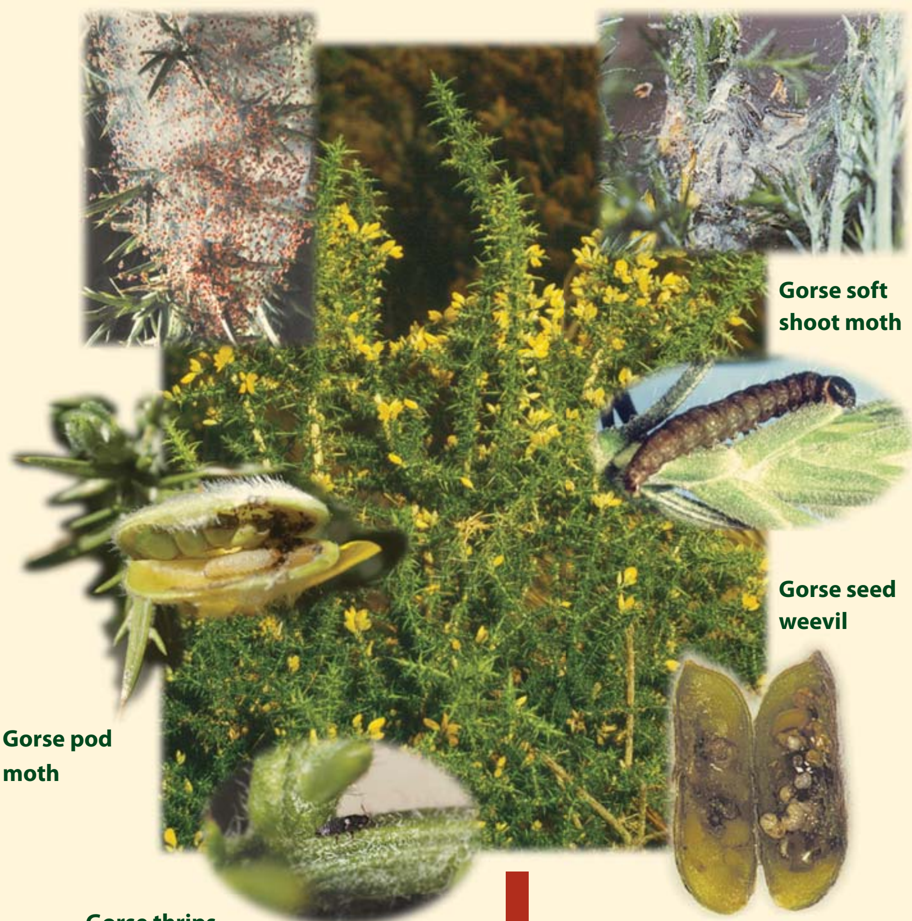
The first agent on the scene by more than half a century was the gorse seed weevil (*Exapion ulicis*). The weevil was released in 1931 and can destroy up to 90% of the spring seed. The gorse pod moth (*Cydia ulicetana*) was introduced more recently (1992) to add pressure to the autumn seed crop, which was at the time getting off scot-free. This moth has two generations a year and complements the seed weevil attack on the spring seeds. A study in Canterbury suggested the two seed feeders were cleaning up most of the spring seed crop, but disappointingly the pod moth was only taking out a small amount (15%) of the autumn seed crop. Overall the two agents were destroying about half of the annual seed crop. "We don't know how representative these figures are of other areas in Canterbury let alone other parts of New Zealand," explained Hugh Gourlay. Surveys in Europe suggest there are no other agents that could be used to further reduce the autumn seed crop.

The gorse spider mite (*Tetranychus lintearius*) was introduced in 1989 from England. These mites established readily in most dry and East Coast areas of New Zealand. Five other strains were released in 1990 that were expected to be better adapted to warm wet climates. Gorse spider mites can severely damage plants and reduce flowering; however, populations large enough to kill mature gorse over wide areas have not been sustained in New Zealand, Australia (Tasmania and Victoria), or mainland USA (Oregon). This is because of predation by a self-introduced small black ladybird (*Stethorus bifidus*) and a predatory mite (*Phytoseiulus persimilis*) introduced to control pest mites in horticultural crops. "In Hawai'i where gorse spider mites have no natural predators, the mites are having a greater impact on gorse growth and seeding," reports Hugh.

Gorse thrips (*Sericothrips staphylinus*) was introduced from England in 1991 and established readily, but initial dispersal appeared to be painfully slow (metres a year). A second population of thrips, originating from Portugal and imported from Hawai'i, was released in 2001. It was thought these thrips may behave slightly differently allowing more rapid spread. Experimental studies indicate thrips prefer new foliage and are capable of significant damage to gorse regrowth and seedlings. "In recent times, we have noticed thrips turning up many kilometres away from known release sites," says Hugh.

The gorse soft shoot moth (*Agonopterix ulicitella*) was first released in 1991 to attack new growth produced in the spring. They were initially difficult to find even though pheromone trapping suggested the moths had established at 10 sites throughout the country. The first major outbreak was not seen until 2004, and the moth appears to be gaining strength in parts of the South Island while still remaining rare in the North Island. Efforts to re-release the moth in the North Island have begun.

"We dropped the gorse hard shoot moth (*Scythris grandipennis*) from the programme in the early 1990s when it proved impossible to rear and the



Gorse biocontrol agents.

colonial hard shoot moth (*Pempelia genistella*) was looking like a much better candidate," confided Hugh. One very small release of the hard shoot moth was made near Lincoln but is not thought to have survived. The colonial hard shoot moth was first released in 1996 and releases are still ongoing. The larvae live in colonies of up to 30 individuals inside communal webs, and devour new and old plant material up and down gorse stems. The moth is so far only known to have established on the Port Hills of Christchurch where it is causing noticeable damage. Given it was a slow starter here we are still hopeful the moth will begin to show up at release sites in other parts of the country fairly soon.

Recent surveys in Europe have confirmed it is unlikely there are any other suitable insect biocontrol agents that could be added to the gorse line-up. Efforts are now underway for an international consortium to secure funding to allow surveys to look for any pathogens that may offer some potential. The possibility of developing mycoherbicides out of two diseases that naturally occur in New Zealand, fusarium blight (*Fusarium tumidum*) and silver leaf fungus (*Chondrostereum purpureum*), has been explored in recent times. However, attempts to develop consistently effective products have met with considerable difficulties and further funding is required to enable this work to continue.

As a bonus a couple of native insects are also doing their bit for the cause. An endemic stem-feeding moth (*Anisoplaca ptyoptera*) commonly attacks gorse in the South Island. This moth is believed to have originally lived on species of native broom (*Carmichaelieae*). The larvae "ring-bark" mature gorse stems causing dieback. In the North Island similar damage is often caused by an exotic insect pest, the lemon tree borer (*Oemona hirta*).

Gorse models suggest biocontrol should be able to reduce the rate at which gorse invades new areas and also the lifespan of gorse bushes – which will cause infestations to decline. Given that we still don't have a single site where all the gorse agents are present in good numbers it could be many decades before we see if these predictions come true. In the meantime we need to be relentless about attempting to establish gorse pod moth, thrips, soft shoot moth, and colonial hard shoot moth everywhere from Cape Reinga to Bluff.

Report Card: Biocontrol of Gorse Agents	
Gorse Seed Weevil	A workhorse that can reliably be found throughout New Zealand (with the exception of the West Coast of the South Island) pulling its weight by destroying many seeds every spring.
Gorse Pod Moth	A sly dog that has quietly inhabited gorse in many parts of New Zealand without people realising, even reaching the Chatham Islands. Is not hitting autumn seeds as hard as hoped and has been caught associating with other exotic legumes.
Gorse Spider Mite	A heartbreaker that started off with a hiss and a roar and caused much excitement until its enemies caught up with it. Still common enough and manages the odd good show during the warmer months.
Gorse Thrips	A dark horse that is also quietly colonising gorse without people noticing. Potentially devastating to seedlings and, unlike the flighty gorse spider mite, this little sucker can mount a sustained attack that renders large plants a little worse for wear.
Gorse Soft Shoot Moth	A slow starter that had almost been written off as a dead loss before managing some spectacular outbreaks in the South Island. Hopefully the caterpillars will soon be making short work of new growth throughout the country.
Gorse Hard Shoot Moth	A hopeless case that point-blank refused to reproduce on demand. Was quickly dropped in favour of its gregarious cousin below.
Gorse Colonial Hard Shoot Moth	A one-eyed Cantabrian that is so far only browning off gorse around Christchurch. We are sure this sociable beast will eventually be tempted to spread its wings.
Areas Needing Improvement	Good grief, we still don't have a single site where all the agents are present in good numbers!
Future Prospects	Unless any pathogens have been keeping a low profile in Europe, the current line-up may be it for gorse. People who know lots about the plant who have gotten together with people who are good at maths think biocontrol may eventually give gorse its comeuppance if we can just be patient for a few more decades…

Things To Do This Winter

There is not much to be done at this time of the year as most control agents hide away or become dormant. However, you can still:

- Check nodding thistle crown weevil (*Trichosirocalus* spp.) release sites. Although some weevils lay eggs all year round, most begin to lay in the autumn and the damage to the rosettes becomes more noticeable as the winter progresses. Look for leaves that have lost their prickliness and for black frass in the crown. Although nodding thistle (*Carduus nutans*) is the preferred host you may also find other species of thistles are attacked too. Crown weevil adults can often be successfully harvested and shifted around as late as June. To see the adults you will need to look carefully on the undersides of the leaves. **You may also be able to collect some for us for a new study we wish to undertake (see box below).**
- Shift ragwort flea beetles (*Longitarsus jacobaeae*) around, provided you can find them in good numbers.
- Make sure all the paperwork relating to release sites is up to date. If you have been shifting agents around then we would be interested to know about this (send information to Lynley Hayes).

Crown Weevils Needed for Research- Can You Help?

There is some uncertainly about what species of crown weevil we have attacking thistles in New Zealand. The weevil imported to New Zealand in the 1980s to attack mainly nodding thistle (*Carduus nutans*), and later released widely throughout the country, was believed to be *Trichosirocalus horridus*. Later, in the 1990s, we sent some weevils to Australia where colleagues there noticed some weevil populations appeared to have definite host preferences. They then sent samples to weevil experts in Spain who decided *T. horridus* was in fact a species complex that should be split into three species: *T. horridus* (a *Cirsium* specialist), *T. mortadelo* (a *Carduus* specialist), and *T. briesei* (an *Onopordum* specialist). The performance of the weevils has been variable in New Zealand, so we would like to check what species we actually have established on various thistle species. If we find that some weevils are established on suboptimal hosts it may be possible to improve control by releasing the species that is best for that host. In order to check this out we need samples of weevils from all over the country, from sites where the weevils are doing well and doing poorly, and from nodding, Scotch (*Cirsium vulgare*), winged (*Carduus tenuiflorus*), slender-winged (*Carduus pynocephalus*), plumeless (*Carduus acanthoides*), and cotton (*Onopordum acanthium*) thistles. If you think you might be able to collect a few weevils for us please contact Lynley Hayes (hayesl@landcareresearch.co.nz, Ph 03 3256-701 ext 3808) for a collecting kit. We will let you know what we find out in a future newsletter.

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