What's New In Biological Control Of Weeds?

What's Inside:

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Manaaki Whenua
Landcare Research

Outbreak!

Moths go mad at Blenheim

After finding the gorse soft shoot moth (*Agonopterix ulicetella*) was alive and well in the Lincoln area last summer we have had even better news this year. Lynley Hayes and Ben Minehan (Marlborough District Council) visited a release site near Blenheim in early December where 700 caterpillars were released in January 1996. "Pheromone traps put out in July 2003 had come back with 13 moths in them so we knew they had established but we weren't prepared at all for what we found," explained Lynley. "We didn't even need to get out of the car to see the caterpillars and their webs; they were that obvious." There were huge numbers of caterpillars feeding away at the site and significantly damaging the new growth. Most bushes over an area of about 5 ha, and even tiny seedlings, were being heavily attacked. In many cases every new growth tip on some plants was affected.

This level of attack has been occurring now for some years in Hawai'i and we had been hoping it might one day also occur here. The moths have also dispersed out into the surrounding countryside. "We found them 9 km away, which was the furthest point checked," explained Lynley. A field day will be organised at this site next December to let people know about this and other gorse biocontrol agents and to allow them to take agents home to assist with redistribution.

Ben Minehan at the gorse soft shoot moth hotspot.

Subsequent checks of other South Island release sites have revealed that the moths are also doing well (although not quite as well as at the Blenheim hotspot) at a site in North Canterbury, and that they have established but are not yet common at a site south of Christchurch and at two sites in South Canterbury. Next December we hope to check some of the North Island release sites. The best time to see the caterpillars is in early summer when they are about half-grown. Before that they are too small to spot easily. Initially the caterpillars are olive-brown in colour and later turn dark green when they are

Gorse soft shoot moth caterpillar

Broom psyllid adults

nearing pupation. Pupae often fall out of the webs onto the ground so, once they have developed through to that stage, they will not be easy to identify unless the damage to new growth is so severe that it can't possibly be anything else.

Meanwhile the gorse colonial hard shoot moth (*Pempelia genistella*) is also going from strength to strength at a site in Redcliffs, Christchurch. Hugh Gourlay and Julia Wilson-Davey report noticeable damage is showing up next to the webs due to larval feeding. "The whole gorse patch has a slight brown tinge due to dead or dying branches," described Hugh. Larvae have also been found at Lansdowne Valley, almost 14 km from the nearest release site. As we were under the impression that the moth was slow to disperse it appears they are actually getting around a lot faster than we previously thought.

Broom psyllid boom

We were also thrilled to find a proliferation of broom psyllids (*Arytainilla spartiophila*) on our broom patch here at Lincoln this spring. This is the home of the first ever release, made in February 1993 – we put out about 80 individuals, which was all we had at the time! Despite the low numbers the psyllids established readily and had been easy to find there each spring but were not doing anything startling. This year we got a pleasant surprise. Several members of staff reported walking through clouds of psyllids when they checked out goings on in the broom patch. "You had to remember to keep your mouth closed when you were working there," commented Julia Wilson-Davey.

This was the first time too that we have seen significant damage. The plants were covered in sticky droplets because the psyllids produce honeydew as they feed. Some stems were black due to a sooty mould growing on the honeydew. Greyish, mottled foliage was noticeable where the psyllids had been feeding and some new leaf buds were blackened and dead. We are keen for others to check psyllid sites next spring and let us know if these are starting to show similar results.

The moral of the story

Biocontrol agents are hard to detect at low levels and as populations grow relatively slowly for the first few generations it can seem like there is nothing much happening for quite a few years following a release. However, populations are often actually quietly growing exponentially, so an outbreak can appear to come all of a sudden. We need to be incredibly patient and not write off any of our agents too soon. Some may take longer than a decade to build up to damaging levels.

Weighing Up the Risk

In December the Environmental Risk Management Authority convened a hearing to discuss Environment Canterbury's application to introduce the boneseed leaf roller (*Tortrix* sp.). As a result of formally notifying this application ERMA received 13 submissions including six in favour, four against and two that were neutral. The hearing provided an opportunity for all interested parties to talk through the issues surrounding the possible introduction of this potential new biocontrol agent.

In its native South Africa, despite heavy parasitism, the boneseed leaf roller outbreaks from time to time and can completely defoliate boneseed (*Chrysanthemoides monilifera monilifera*) plants. Comprehensive field surveys in South Africa have revealed that, despite at times encountering severe food shortages, the leafroller has never been found attacking any other plants except bitou bush (*Chrysanthemoides monilifera rotundata*). This positive finding led Australian researchers to begin a host-testing programme and they have subsequently released the leafroller there. However, the leafroller, like many moths, did not prove easy to test. When put in a no-choice situation inside a cage the caterpillars fed and developed on a wide range of plants, including species that are not attacked in the field in its native range. A number of field tests were then carried out to demonstrate that the lab results were indeed "false positives" and that the agent posed a low risk to other plants. When we decided to test the plant for New Zealand we were able to benefit from the Australians' experience and test only a few additional plants using the method that gave the most accurate results.

A large part of the hearing was devoted to explaining the results of the host-specificity tests and how the test plant list was chosen. "Surrogate" species that were available in South Africa, instead of New Zealand native species, were used to represent some genera.

Boneseed leafroller adult

This is an accepted practice under international protocols. Two expert witnesses also took the stand. Barbara Barrett of AgResearch provided an independent assessment of the host testing carried out and Ilse Breitwieser of Landcare Research commented on issues relating to plant taxonomy.

A number of questions were raised by the ERMA panel and submitters including:

- the effect of climate on test results – there are no examples of agents having different host ranges in different environments.
- whether host-range expansion has ever occurred after release – again there are no examples of this ever having happened.
- the risk that different ecotypes of the moth might have different host ranges – only moths from the same area that were tested would be imported.
- the safety record of biocontrol – this is pretty good.
- likely interference from parasites/ predators – unlikely to be a hindrance given that the leafroller is still successful despite getting a hard time in its native range.
- the success of the Australian biocontrol programme – still too early days to know.

There was also discussion about why boneseed is a problem and what might happen if it is and isn't controlled. After the hearing the ERMA panel went away to deliberate. We expect to be notified of their decision towards the end of February.

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

Never Work with Children and Animals?

Weeds beware – children and insects are working together to gang up on pesky plants! A programme that teaches primary school children about weeds and how to rear biocontrol agents was trialled in Canterbury late last year. It was developed by Julia Wilson-Davey and Richard Goldsbrough, who was able to take a year off teaching thanks to a Royal Society Teaching Fellowship, and is based on the Australian "Weed Warriors" programme (see *Enlisting New Weed Warriors*, Issue 26). Richard and Julia have adapted the programme to the New Zealand environment and linked it to school restoration projects. "The aim is to raise the childrens' awareness of weed issues, improve their understanding of biological control, and get them involved in some practical science," explained Richard.

The programme was trialled at four schools in the Christchurch area during the third term and involved three class visits. Richard took charge of the first lesson and introduced the topic of weeds. He covered the impacts of weeds and related this to the restoration projects being undertaken by the schools. The children then introduced ten of the most common weeds in the region to the rest of the class in imaginative presentations. "The most focused part of the lesson, however, was when the students were making a little weed booklet to write their notes in," joked Richard.

The second lesson, which involved learning about biological control, was Julia's turn. "The topic involves some quite complicated concepts and I was impressed by the childrens' level of understanding," admitted Julia. The lesson culminated with the class being introduced to a population of gorse spider mites (*Tetranychus lintearius*). For the next 5 weeks the children were responsible for looking after these little animals, and were quick to call Julia if things did not go as expected, such as the mites taking off to explore the classroom! The final school visit revised the previous lessons and wrapped up the programme with a trip out of the classroom to release the spider mites.

Julia and some pupils at St Josephs School pretend to be gorse bushes.

Richard and Julia were pleased with the positive feedback from teachers and the children to the trial. It really was a learning experience for all involved! Julia is encouraged by the amount of interest shown from around the country following some media coverage of the children's gorse spider mite releases and will be continuing to work on the programme this year. She is keen to develop rearing protocols for other biocontrol agents to make the programme even more valuable.

Richard and Julia would like to make their programme available to all who are interested. The programme structure and lesson plans will be loaded on to the Weedbusters (www.weedbusters.org.nz) and Landcare Research (www.landcareresearch.co.nz) websites in due course. Anyone familiar with environmental weeds issues and biological control principles could deliver the programme. The programme is adaptable, so schools do not necessarily have to be involved in a restoration project to enjoy it. Classes could also choose to observe a biocontrol agent in the field rather than keep it in the classroom. "However, this would be missing half the fun!" exclaimed Julia. Watch this space!

Please contact Julia Wilson-Davey if you have any queries about the educational programme (wilson-daveyj@landcareresearch.co.nz or Ph 03 3256 700).

Out of Africa

Recently we were asked by the Auckland Regional Council to investigate the feasibility of using biological control against African club moss (*Selaginella kraussiana*). This weed is unusual in that it belongs to a very primitive group of plants called fern allies (class Lycopsida). African club moss was introduced to New Zealand as a ground cover for gardens and was first recorded in the wild in 1919. Today it is widespread in the North Island and scattered throughout the South Island and Chatham Islands, and is most commonly found in damp, shady sites, such as lowland forests and stream banks, and in gardens and nurseries. Although it has also naturalised in Australia, Europe, and northern, central and southern America it is not considered a problem there – yet!

African club moss creeps along the ground on wiry fern-like stems and is able to spread by spores and stem fragments. It can form thick carpets that suppress native forest floor plants, such as orchids and ferns. "African club moss is difficult to control because it is very effective at reinvading areas that have been cleared," explained Jane Barton, who undertook the investigation. Current methods of control are very labour-intensive and need to be repeated regularly.

Conflicts of interest due to potential biocontrol agents causing non-target damage are likely to be negligible. The genus *Selaginella* is quite taxonomically isolated, being the only genus in the Selaginellaceae family, and there are no *Selaginella* species that are native or economically important to New Zealand. A small number of *Selaginella* species are grown here as ornamentals but Jane warns that "they have the potential to become invasive too." This means that potential agents might only need to be specific to the genus and not the species.

Very little is known about the natural enemies of African club moss. None are recorded from the plant in New Zealand but a number of species have been observed damaging *Selaginella* species overseas. These include the same kinds of creatures that have been used as biocontrol agents before, e.g. two smut fungi (*Melaniella oreophila* and *M. selaginellae*), a rust fungus (*Uredo vetus*), a thrips (*Echinothrips selaginellae*), and two butterflies (*Acrophtalmia artemis* and *Ragadia luzonia*). Many butterflies of the genus *Euptychia* are also known to feed on other *Selaginella* species and it might be possible to find a species that can attack *S. kraussiana* despite never having encountered that species before. When such novel associations occur a biocontrol agent may be extremely damaging because no "equilibrium" has evolved between the plant and the agent. Other insects worthy of further investigation include a sawfly and several gall-forming flies.

African club moss is the first fern ally worldwide to be considered for biological control. "Since we would be breaking new ground it is difficult to know whether African club moss could be successfully controlled in this way," concluded Jane. However, there is room for some optimism. We know that their closest relatives, the true ferns, have been biocontrol targets overseas and that projects against red water fern (*Azolla filiculoides*) and salvinia (*Salvinia molesta*) have been extremely successful. It would be worth taking the next step, which would involve looking for potential control agents in the weed's native range. Fancy a safari, anyone?

Jane Barton is a subcontractor to Landcare Research. A copy of the full report is available from Lynley Hayes (hayesl@landcareresearch.co.nz).

Flora of South Africa

Possible Change to Weeds Newsletters

We are considering the possibility of in future producing a single weeds newsletter which would cover weeds research carried out by Landcare Research and other organisations, and be produced quarterly. Under this scenario "What's New in Biological Control of Weeds?" and "Wise up to Weeds!" would cease to exist. Obviously there are pros and cons with this possible approach so we would like to know how our readers feel before we make any firm decisions. So please tell us what you think! Contact Lynley Hayes (hayesl@landcareresearch.co.nz, or Ph 03 3256 701 ext 3808).

Tussling with Tussocks on Their Home Turf

"Finding a biocontrol agent for nassella tussock (*Nassella trichotoma*) and/or Chilean needle grass (*N. neesiana*) is proving to be a tough job," reported Jane Barton on her return from Argentina, the homeland of the weed. Jane was there for 2 weeks in November to assist pathologist Freda Anderson who has been working diligently on this task for us and the Co-operative Research Centre for Australian Weed Management. Pathogens rather than insects have been the focus of this project since the beginning because of the high level of host specificity required to tackle weedy grasses.

This project has been beset with difficulties. Freda has had to contend with a hot, dry summer when pathogens were scarce, working in a country on the brink of economic collapse, and changes to quarantine facility regulations in Australia that dashed hopes of undertaking some of the work there. In addition, the pathogens that Freda has been working with have all been impossible to grow in culture. This means that the only way to maintain them is to regularly collect spores from infected plants, and inoculate them on to new fungus-free but susceptible plants grown in the glasshouse. Plants inoculated with each fungus strain have to be kept separate, so that Freda can be sure of the identity and origin of each organism she's working with. "While facilities at CERZOS, the research institute where Freda works, are pretty good, they're not unlimited and she can really only work on one or two different organisms at a time," explained Jane. And just to make things even harder, the leaves of nassella tussock are very tightly rolled up, with the stomata on the inside, and that makes it difficult to inoculate the plants and harvest spores for experiments.

Until recently, the pathogen that seemed to show the most promise for biological control of both grasses was a rust called *Puccinia nassellae*. This is the only pathogen on the "shortlist" so far that Freda has found infecting both *Nassella* species. Unfortunately, individual isolates or "strains" of the rust seem to be specific to one species or the other, so it may not be possible to find one organism that can attack both. Also, this rust has a very complicated life cycle and so far Freda has been unable to coax it to produce one particular spore stage (aeciospores) on nassella tussock. It may be that the rust has lost the ability to produce aeciospores, but it is also possible that it produces these spores on another, as yet unknown host. In fact, recent laboratory experiments suggest that the rust probably needs an alternate host and Freda is redoubling her efforts to find a plant growing in close association with nassella tussock that could be such a host. If this hypothetical plant is found it would probably preclude the rust from being used. That's because host range testing would have to include not only lots of grass species, but also representatives from the family of the alternate host, and this would be prohibitively expensive unless the alternative host belonged to a family that doesn't occur here, or was also a noxious weed.

> With this project, invariably there is a catch.

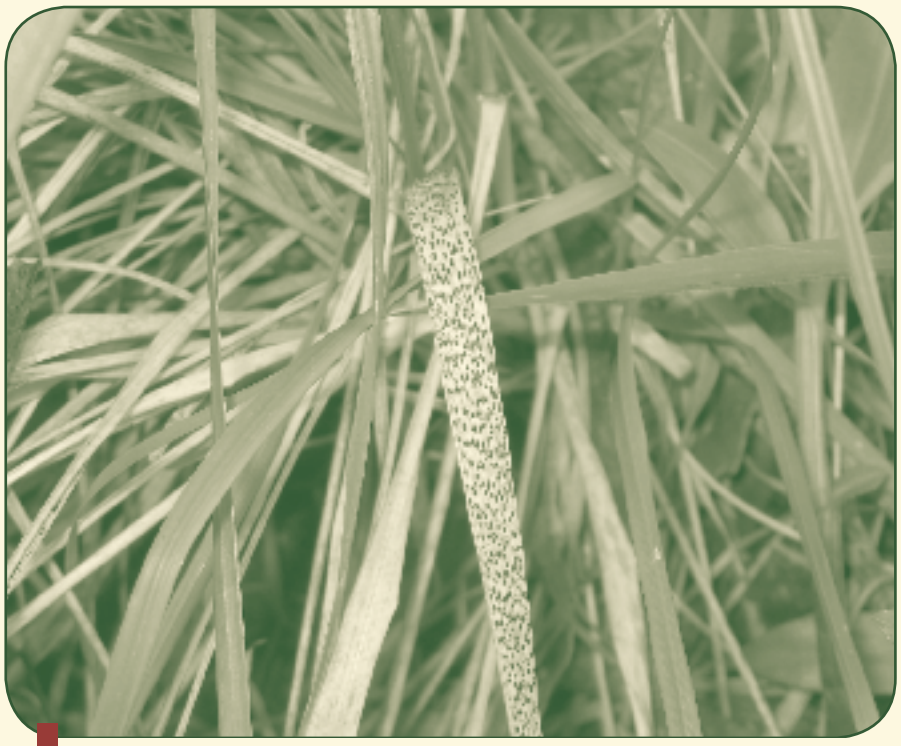
The other two pathogens initially thought to have potential against nassella tussock, a smut (*Ustilago sp.*) and an unidentified mushroom-like corticaceous species, are still on the back-burner because they are even more difficult to work with than the

Freda Anderson amongst flowers of nassella tussock at one of her field sites near Bahía Blanca in Argentina.

rust. Jane saw the corticaceous fungus associated with impressive dieback of nassella tussock in the field in Argentina. However, Freda explained that "the dieback happens in some years, not others; we're not sure if the fungus causes the dieback or if it's there as a secondary invader. We can't isolate it on artificial media and efforts to do host range testing with it in the glasshouse and the field have to date proved fruitless". Unfortunately, the dieback observed at this site was in stark contrast to the health and vigour of most of the nassella tussock plants seen by Jane in Argentina. "The only thing that really seems to keep the plant under control here is competition with lots of other vigorous grass species," confided Freda.

On the bright side, there are other pathogens with potential as biocontrol agents for Chilean needle grass, and this plant is easier to work with because it has flat leaves. While Chilean needle grass is currently less of a problem than nassella tussock in both Australia and New Zealand, it has very sharp seeds that can injure livestock and downgrade pelts, and as it is very difficult to control it is a significant problem where it occurs. There are two rusts, in addition to *Puccinia nassellae*, that Freda has frequently found attacking Chilean needle grass in the field in Argentina: *Uromyces pencanus* and *Puccinia graminella*. *Uromyces pencanus* can be very damaging in the field and Freda has successfully infected six out of seven accessions of Chilean needle grass sent to her as seed from Australia. She will test New Zealand material soon. According to the literature this rust has a narrow host range and completes its life cycle on its grass host so it could be a good biocontrol agent. There's only one fly in the ointment: like *Puccinia nassellae* no aeciospores belonging to *U. pencanus* have been found to date, which means the literature could be wrong and an alternate host may exist. Efforts are now concentrated on solving this dilemma.

Puccinia graminella can also be very damaging to Chilean needle grass in the field and happily, this rust produces aeciospores as well as dark, thick-walled resting spores (teliospores) on this host. That means it definitely doesn't have an alternative host! The catch with this fungus (yes, with this project, invariably there is a catch) is that it doesn't seem to produce another spore type: urediniospores. Urediniospores are the rust-coloured spores that most rusts use as their dispersal stage and this is the spore type that is typically used for doing testing and for making releases. Freda has only just started working on *P. graminella* and it will be intriguing to see if she is able to "bulk up" the rust with only aeciospores and teliospores to work with. According to the literature this fungus is specific to three closely related genera of grasses (including *Nassella*). Thus it is potentially less host specific than the other fungi discussed above, but it may still be specific enough for Australia and New Zealand. Only time will tell, and there's no shortage of challenges ahead in the battle to control these two truly formidable tussocks. And yes, before you ask, Jane did wash all her clothes and equipment very carefully before returning to New Zealand from all those *Nassella* infested field sites!



Teliospores of Puccinia nassellae *on Chilean needle grass in Cordoba, Argentina.*

Jane Barton is a subcontractor to Landcare Research. New Zealand's contribution to the Nassella *project is funded by a national collective of regional councils and the Department of Conservation.*

Things To Do this Autumn

Before you start winding down to winter there are a few things you might need to plan for this autumn, including:

- Checking gorse patches for the gorse pod moth (*Cydia ulicetana*). Autumn is the best time of year to check pods for the creamy-coloured caterpillars, since there is no chance of confusing them with gorse seed weevil (*Exapion ulicis*) larvae. You can tell when a caterpillar has eaten all the seeds and moved on because they leave behind some granular frass and an exit hole. The gorse pod moth is dispersing quickly so you might be surprised just how widely you find them. Also keep a look out for the small brown adult moths fluttering around gorse bushes, especially on sunny, calm days. If you need to introduce the moth to new areas simply cut off branches with infested pods and wedge this material into gorse bushes at new sites.

- Checking Portuguese gorse thrips (*Sericothrips staphylinus*) release sites. It is best to check bushes when they are not flowering so you don't confuse the thrips with flower thrips (*Thrips obscuratus*). Beat branches over a piece of white card or material, and if numbers are good you could shift infested material to new sites. It would also be useful to check how far they have dispersed.

Mist flower gall fly gall

- Checking sites where gall-forming agents have been released. The mist flower gall fly (*Procecidochares alani*), hieracium gall midge (*Macrolabis pilosellae*), hieracium gall wasp (*Aulacidea subterminalis*), and Californian thistle gall fly (*Urophora cardui*) all cause swellings that develop through summer and become most obvious in early autumn. If present in good numbers you could harvest mature galls and release them at new sites. However, leave hieracium gall midge sites alone at this stage as we are still investigating the best way to redistribute this agent.

- Harvesting Scotch and nodding thistle gall flies (*Urophora stylata* and *U. solstitialis*). Keep an eye out for mature flowerheads that look fluffier than usual. Give them a careful squeeze and if they feel hard and lumpy they are infested. Put infested flowerheads in an onion or wire mesh bag, or similar, and hang it on a fence at the new release site. The galls will slowly rot down over winter and the flies will emerge in the spring and attack the thistles.

- Harvesting and redistributing nodding thistle crown weevil (*Trichosirocalus horridus*) and ragwort flea beetle (*Longitarsus jacobaeae*). Take time to check through the material you collect to ensure that you are not spreading pests, such as the clover root weevil (*Sitona lepidus*), as well as the biocontrol agents.

Remember to read up the relevant pages in "The Biological Control of Weeds Book" before embarking on any of these activities, and let us know how you get on!

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