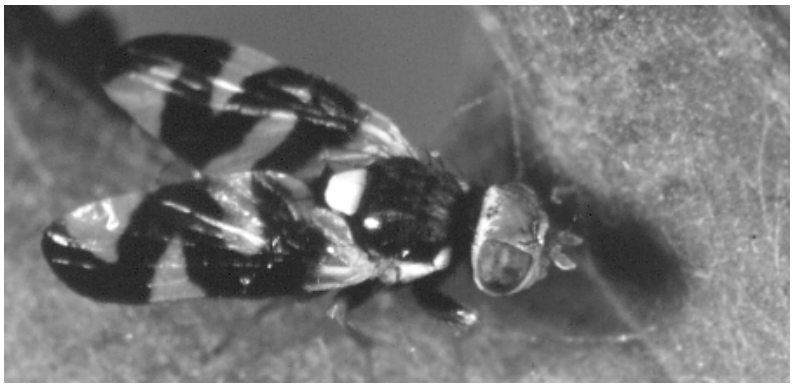
Number 15 May 2000

What's New In Biological Control of Weeds?

What's Inside?

Californian Thistle — the Agony and the Ecstasy

Two foliage-feeding beetles *(Lema cyanella, Altica carduorum)* and a gall-forming fly *(Urophora cardui)* have been introduced to New Zealand to attack a perennial thorn in many people's sides, Californian thistle. Two agents introduced against other thistle targets, the nodding thistle receptacle weevil *(Rhinocyllus conicus)* and Scotch thistle gall fly *(Urophora stylata)* may also attack the plant slightly. While researchers suspected all along that further agents would be needed to topple such a vigorous and persistent menace, the lack of suitable agents available combined with difficulties finding funding meant that the project languished in the too-hard basket for several years. That was until a group of farmers from Otago/Southland came along and breathed new life into it. With Grant Catto at the helm, the Californian Thistle Action Group managed to persuade the Agricultural and Marketing Research and Development Trust (Agmardt) to provide funding for a 3-year period, and for local councils to pitch in and help too. The aims during the first year of this project were to check on progress being made with the weed worldwide, to support an international survey to find new agents, and to look at ways of making the most of the agents we already have here. Over the page we recap on the highs and lows encountered so far.



Californian thistle gall fly

What's the rest of the world doing about Californian thistle?

People started looking for Californian thistle control agents way back in the 1960s. Despite numerous surveys over the years, only a small part of the native range (mostly Western Europe) has been covered yielding only four insects (Table 1). "Of the four only the gall fly *(Urophora cardui)* is believed to have any significant impact," reports Simon Fowler. Five further agents have established on Californian thistle under their own steam (Table 2), again with mixed success. However in some locations, several of these natural enemies are helping to suppress Californian thistle.

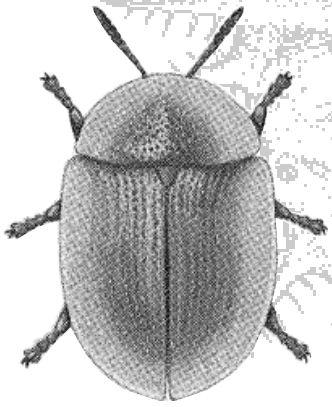
Table 1. Agents deliberately introduced to attack Californian thistle

Agent	Canada	USA	New Zealand
Altica carduorum Foliage-feeding beetle	Poor establishment and unable to cause significant damage	Failed to establish	Believed to have failed to establish
Ceutorhynchus litura Root/stem-mining weevil	Can reduce shoot production but impact minimal	Lowers the survival rate of plants over the winter	Small number released in a field cage failed to survive
Lema cyanella Foliage-feeding beetle	Poor establishment and impact	Not released	Poor establishment and impact
Urophora cardui Gall-forming fly	Causing thistles to decline in some areas	Plants stunted but impact minimal	Just beginning to establish in the field, releases continuing

Table 2. Self-introduced European agents found on Californian thistle

Agent	Canada	USA	New Zealand
Cassida rubiginosa Foliage-feeding beetle	Can stress plants but impact tends to be minimal	Can severely damage plants and combined with vegetation management can help to control thistles	Considered insufficiently host-specific to release in New Zealand
Cleonus piger Root/foliage-feeding weevil	Possibly contributes to thistle control in some places	Not present	Considered insufficiently host-specific to release in New Zealand

Dasyneura gibsoni Flower gall midge	Destroys some seeds	Not present	Not present
Larinus planus Foliage-feeding beetle	Impact unknown	Impact on seed production believed to be minimal	Considered insufficiently host-specific to release in New Zealand
Puccinia punctiformis Rust fungus	Level of attack generally low limiting impact	Can kill plants but generally has low impact	Can reduce vigour and retard growth in localised patches. Negligible impact in Australia
Terellia ruficauda Seed-feeding fly	Can destroy up to 90% of seeds	Not present	Not present



Cassida rubiginosa (adult & larva)

Other potentially useful natural enemies have come to light but these have not yet been well studied (Table 3). "Controversy in North America about risks to native thistles has stalled progress towards developing further classical biological control agents," explains Simon. "In recent times the main thrust of research has turned towards plant pathogens that might cut the mustard as mycoherbicides. Mycoherbicides have the advantage in that they could be kept away from native thistles" (Table 4).

Getting to the root of the problem

Recent evidence now suggests that the centre of origin for Californian thistle lies further east than previously thought, so many researchers are now of the opinion that surveys in eastern Europe and western Asia might be worthwhile, especially now that these parts of the world have become more accessible to foreigners. This year we contributed to a survey of southern Russia led by André Gassmann, of CABI Bioscience, Switzerland. André and colleagues are, in particular, looking out for stem- and root-boring insects that may damage the plant sufficiently on their own or work in well with pathogens. Unfortunately André's team did not unearth anything new and will now turn their attentions to Uzbekistan in 2000, China in 2001, and Siberia and eastern Russia in 2002.

Table 3. Potentially useful insects known to warrant further investigation

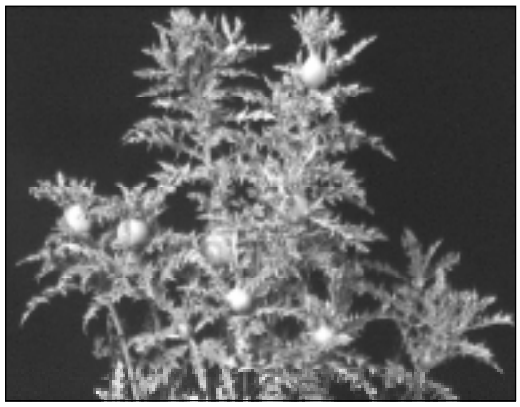
Cheilosia sp. Stem/root-boring fly	Found during previous surveys, other *Cheilosia* spp. are often extremely host-specific
Corythuca disticta Lace bug	Insect native to the USA, has been distributed to a small extent as a biological control agent
Dyaphis lappae Root aphid	Recorded from Denmark, warrants further study
Lixus sp. Stem-boring weevil	Common in China, likely to be host-specific. A close relative, *Lixus cardui*, has proved useful against *Onopordum* in Australia
Thamnurgis caucasicus Root-boring beetle	Commonly found in previous surveys, warrants further study

Table 4. Potentially useful pathogens under investigation

Phoma sp. Fungus	Promising new discovery in New Zealand, under investigation by HortResearch. Appears to attack a range of thistles
Phomopsis cirsii Fungus	Chosen from six fungi found in Denmark as having greatest potential for mycoherbicide development. Appears to be restricted to the subfamily Cardueae, artichokes are likely to be susceptible
Pseudomonas syringae pv. *tagetes* Bacterium	Under investigation in the USA as a potential mycoherbicide for use in soybean crops. Attacks other members of the Asteraceae family including sunflowers and marigolds
Sclerotinia sclerotiorum Fungus	Under development by AgResearch in New Zealand. Has a wide host range so limited to use in pastures. Have been problems developing formulations that work reliably in the field
Septoria cirsii Fungus	Under investigation in Russia but conditions required for infection are probably too restrictive for it to have mycoherbicide potential. Appears to be restricted to the genus *Cirsium*

Making the best of a bad bunch

The third aim of the Agmardt project was to try to make the best use of the three agents that have already been released in New Zealand, by getting farmers to assist with rearing and spreading them about. There was some doubt in our minds about whether or not anything could usefully be done with the two foliage-feeding beetles so local expert, Tom Jessep, was called out of retirement to help. We needed to check if the beetles had survived in collectable quantities in Otago/ Southland. The beetles are renowned for being difficult to find in the field so a number of methods were employed. First of all traps were set up at release sites, designed to snare any beetles flying about in the spring, and later Tom made a thorough inspection of each site armed with a sweep net and a garden leaf-vacuum. Unfortunately not even Tom was able to find a single solitary beetle and it appears unlikely that either species has survived in the lower South Island. The leaf beetle has hung on in low numbers elsewhere in the country but we are not holding out much hope for the flea beetle at all. "After consulting with our Canadian colleagues, who have assessed the leaf beetle and found it wanting, a decision has been made not to do anything more to promote the leaf beetle, " reports Simon. "However, the possibility of further work with the flea beetle has not been discounted as better strains have since been discovered in China."



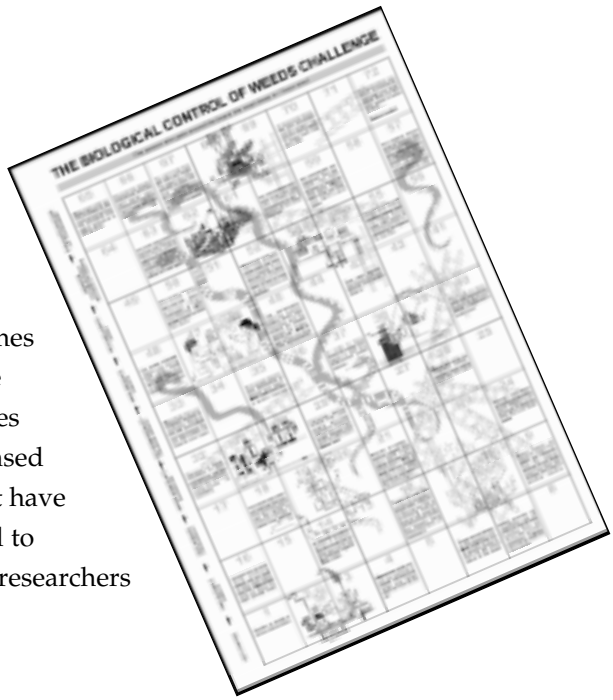
Californian thistle plant covered in galls

Of all the agents trialled so far, the Californian thistle gall fly has shown the most promise. Only a handful of releases have been made of this fly so there is a lot of scope for improving its current distribution. Often the best way of rearing agents is outdoors under natural conditions, so this year eight willing farmers/ regional council staff were selected to have a go. Frank Rosie, of the Otago Regional Council, made an excellent job of arranging for 40 special cages to be made, and then a field day was held at Mt Linton (near Queenstown) in January to show everyone how to set them up properly and get started. This cage rearing turned out to be a success. Starting with only three pairs of flies in each cage, 25 of the cages managed to produce between 6 and 30 galls each. Since we can expect anywhere between 1 and 30 flies to emerge from each of these galls next spring, Frank, you'd better start making plans to build a whole lot more cages! It is hoped that this field rearing can continue for a number of years until the distinctive galls become a regular feature on farms nationwide. By that time, hopefully we will have some new agents to work alongside them.

Field day at Mt Linton. Frank Rosie shows how to put his cages up

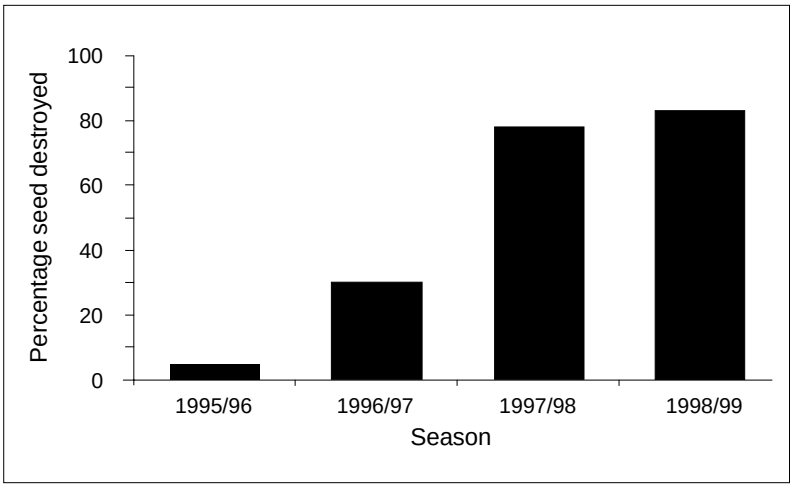
Snakes & Ladders

We biological control of weeds researchers in New Zealand rely on all you good people out there to make our programmes work. We cannot do it alone. To enhance your understanding about why biological projects succeed or fail we have designed a special version of Snakes & Ladders (enclosed) that we hope you will find time to play. The winner is the person who gets around the board the most times in an hour. Please note that the snakes and ladders are based on real events that have actually happened to biological control researchers in New Zealand!



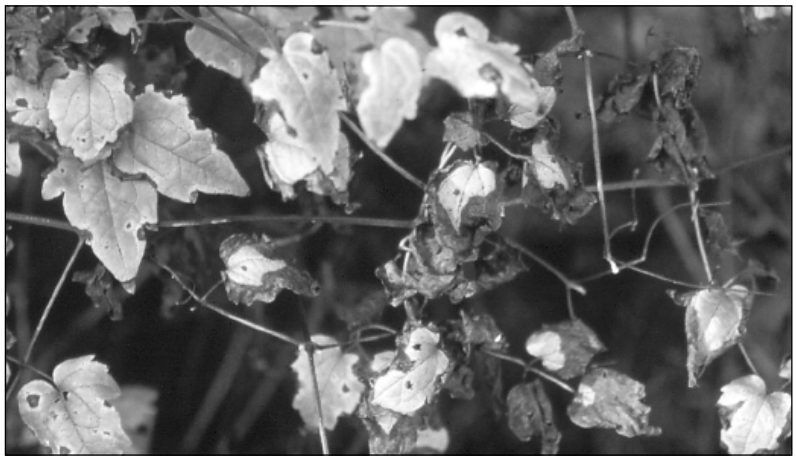
Broom Seed Beetle Rises to the Occasion

Studies have shown that it may be possible to stop broom from spreading at such an alarming rate and even contain existing infestations if we can limit the amount of seeds being produced. A beetle that destroys the seeds *(Bruchidius villosus)* has been imported with this end in mind, and we have been following its progress with great interest at a number of sites, including Tauhara (on the outskirts of Taupo) where 2000 beetles were released in 1993. Two years after the release the adult beetles were still low in number with only about 4% of the total seed crop infested. However, with 3 more years under their belt the beetles had become abundant at the site and increased their hit rate to around 80% (see graph). It is the larval stage that does the damage. The adults lay eggs on the outside of newly formed green pods. The larvae hatch and tunnel through the pod and into the developing seeds where they feed and grow. By the time a larva is fully grown it will have eaten most of the seed that has been its home, and the remnant is no longer viable. We are hoping the infestation rate will rise even further and be repeated at sites throughout the country, but if necessary there are other seed feeders available that we could call upon to add extra pressure, namely, three weevils *(Exapion fuscirostre, Lepidapion* sp., and *Tychius parallelus)* plus another bruchid *(Bruchidius lividimanus).*



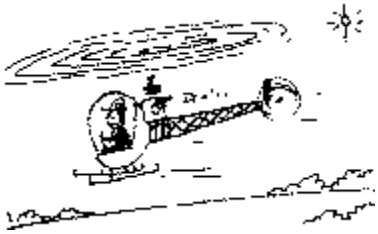
Take a Closer Look at Old Man's Beard Fungus

There still seems to be some confusion out there about how to recognise signs that old man's beard has been infected by the old man's beard leaf fungus *(Phoma clematidina).* If patches of dead, blackened leaves and stems do not obviously jump out at you, try lifting up some of the leaves and looking underneath. Often the top layer of most recent growth still looks relatively healthy and masks the dead and dying growth underneath. You can tell if the top layer has been infected by examining the leaves for tiny black spots. These spots eventually become large blemishes and the leaves take on a yellow appearance before turning completely black and falling to the ground. Stems may also be affected giving the vines the appearance of having had a bad haircut. You are unlikely to notice decayed material once it has fallen to the ground, but rest assured that it is providing lots of lovely inoculum for future infections and is in the perfect position to nab any seedlings that germinate. Most commonly we are seeing severe damage in the autumn, but we have also seen it earlier when there has been a wettish spring and/or summer, when flowers and seed pods may also be affected. At a site near Gisborne where the vines have been severely defoliated for 2 years running, there was virtually no flowering this year.



Old man's beard leaves sharing typical signs of infection by the leaf fungus.

There has been a lot of interest from councils with severe old man's beard infestations about the possibility of broadcasting large quantities of the fungus from a helicopter. Adrian Spiers, of HortResearch, experimented with this technique in a reserve at Taihape (an area famous for its old man's beard as well as gumboot throwing competitions!) back in 1998. Initially he was happy just to get successful infection as the formulation used was by necessity rather crude. Two years on and Adrian has been back to assess the value of this exercise. "From a distance it looked like the fungus was doing nothing; however, once I looked underneath I could see that it was everywhere. All the young seedlings were heavily infected, distorted and going nowhere. When I looked upwards I could see gaps were starting to appear where the vine had died. Regrowth was also noticeably weaker. I came away feeling good that the fungus was really doing something! Given a couple more years the entire infestation in this reserve is going to be looking pretty sick, and I believe the helicopter spraying has been more than justified," reports Adrian.



If you would like more information you can contact Adrian by emailing him at aspiers@hort.cri.nz or by phoning (06) 356 8080.

Local Hot Gossip

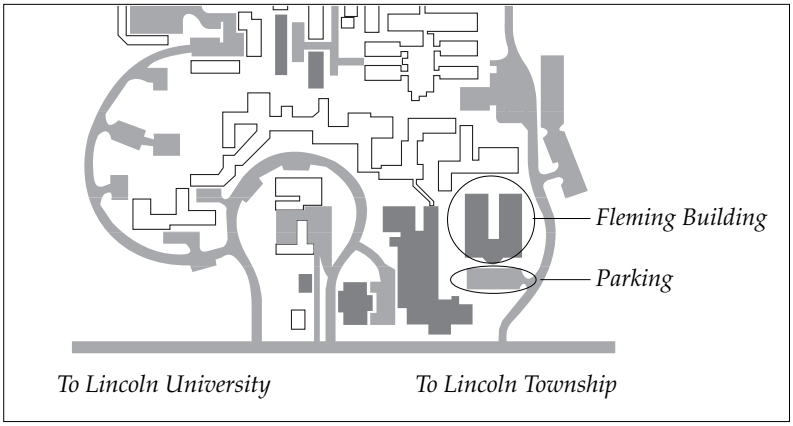
Until recently there has been a lot of doom and gloom surrounding the **gorse colonial hard shoot moth**

Colonial gorse hard shoot moth

(Pempelia genistella). Many problems have been encountered in trying to find a successful formula for mass rearing this seventh and final weapon in the gorse attack. Despite staff spending long hours slaving away in a hot rearing room, caterpillars have been released at only three sites (Lincoln, Christchurch, and Auckland) so far. To add insult to injury, follow-up visits to these sites have failed to find any trace of the moth. That is until this autumn when Hugh Gourlay finally managed to find caterpillars at Lincoln almost 4 years to the day after he had released them there. "I'd almost given up hope and there they were," said Hugh. "The caterpillars are quite hard to spot when they are small so hopefully I'll be able to find even more in the spring." The green and brown striped caterpillars graze on mature foliage during the cooler months of the year and put on a growth spurt in the spring when it is warmer and they can supplement their diet with nutritious new gorse growth. "The moths came from Portugal so it's a relief to know that they can survive New Zealand's cooler conditions," said Hugh. "You have to have a lot of patience in this game and we are now feeling a whole lot more positive that we can get this agent going."

The **mist flower fungus** *(Entyloma ageratinae)* is literally bolting away. Even though the white smut was first released only just over a year ago, it is already turning up all over the place. "This autumn I went over to the Great Barrier Island to release the fungus and found that it was already there," said Jane Fröhlich. "While we can't discount the possibility that the fungus was accidentally carried there on someone's clothes or vehicle, it seems likely that it has blown there from the Waiheke Island release site, more than 77 km away."

Lincoln staff are undergoing a small dispersal of their own from their outpost at the back of the Canterbury Agriculture and Science Centre to Landcare Research's main hub near the main road. Our phone and fax numbers, mail address, and email addresses all remain the same. If you are planning on dropping in some time, please come to the Fleming Building (see map), which is situated just behind the herbarium. Take the driveway opposite Murray Place and park in the visitor's car park just outside the main doors.



Winter Activities

Winter is traditionally a quiet time on the biological control front, when the agents are best left to their own devices. The end of May is usually the cut-off time for harvesting ragwort flea beetles *(Longitarsus jacobaeae)*, although it may be possible to collect nodding thistle crown weevils *(Trichosirocalus horridus)* as late as June. Winter can be a good time to check nodding thistle crown weevil release sites. Some weevils lay eggs all year round, but the bulk of them begin to lay in the autumn and the damage to the rosettes becomes more noticeable as the winter progresses. As the grubs feed in the crown, they produce a black waste substance (frass), and the ribs of the surrounding leaves take on a reddish-brown colour at the base. The leaves of damaged rosettes become less prickly and start to look a bit like dandelion leaves. You may see rosettes that look like this at any time of the year, but the damage is usually most obvious later in the winter and in early spring. If you dig a damaged rosette out of the ground and cut it in half with a pocket knife, you should be able to see the white grubs feeding inside.

Cut open a damaged rosette to see the white grubs feeding inside

People that have gorse soft shoot moth *(Agonopterix ulicetella)* release sites should expect a package from us in early July. The package will contain a newly developed pheromone trap that we hope will end years of speculation about whether or not this agent has established. There are a number of reasons why we have struggled to monitor this agent: the adults are nocturnal so you won't see them flying around during the day, the adults are strong fliers and can spread their eggs over a wide area, small larvae are almost undetectable, larger larvae are only really visible for a narrow window of about a fortnight before they pupate and drop out of sight, and gorse forms dense stands at many sites often making it only possible to check around the edges. The traps should be put out at release sites by mid-July and remain out in the field until the end of August, as studies have shown that the adult moths become sexually active during this time. There is no danger of the traps taking out all the moths at release sites as only the males are attracted to the pheromone, and only a few males are needed to mate with the females. We'll let you know the results of this trapping in the November issue of this newsletter.

Remember to use the wintertime to make plans for the coming busy spring season. Start thinking about suitable release sites for any new agents that you may be receiving from us, and planning harvesting operations for broom seed beetles *(Bruchidius villosus)*, gorse pod moths *(Cydia succedana)*, and gorse thrips *(Sericothrips staphylinus)*.

Tell Me More...

Question: My nodding thistles are as bad as ever. What has gone wrong? Have the control agents stopped working?

No, don't hit the panic button, as this is to be expected! Even though the nodding thistle receptacle weevil (Rhinocyllus conicus) and gall fly (Urophora solstitialis) have been doing an excellent job in recent years at preventing seed from forming, there is still a huge seed bank in the soil just waiting for the right conditions to grow. The two preceding years of severe drought have provided ideal conditions for thistle germination by opening up a lot of bare ground in pastures. The crown weevil (Trichosirocalus horridus) is capable of attacking rosettes, including seedlings, and preventing them from becoming flowering plants. However, with such a bumper crop of thistles the crown weevil has been spoilt for choice and is unable to attack all of the rosettes available, especially in areas where it has previously suppressed thistles and as a consequence become rare. Now that thistle populations are again abundant, the crown weevil populations (and the seed-feeders too) will build up accordingly. The agents will eventually regain control of the thistles. However, be aware that this cycle is likely to be repeated many times over, before the seed bank is exhausted. Even then there may be some years when thistles temporarily become bad again if conditions favour thistle growth and/or do not suit the control agents.

What can I do to help?

- Avoid activities that promote thistle growth e.g. anything that opens up pasture.
- Avoid activities that harm the agents, e.g. mowing or spraying the thistles when the agents are developing inside and are unable to escape (refer to "The Biological Control of Weeds Book" for more details about their life cycles).
- Check that the agents are still present and if necessary arrange for a top-up release.

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