Number 18 May 2001

What's New In Biological Control of Weeds?

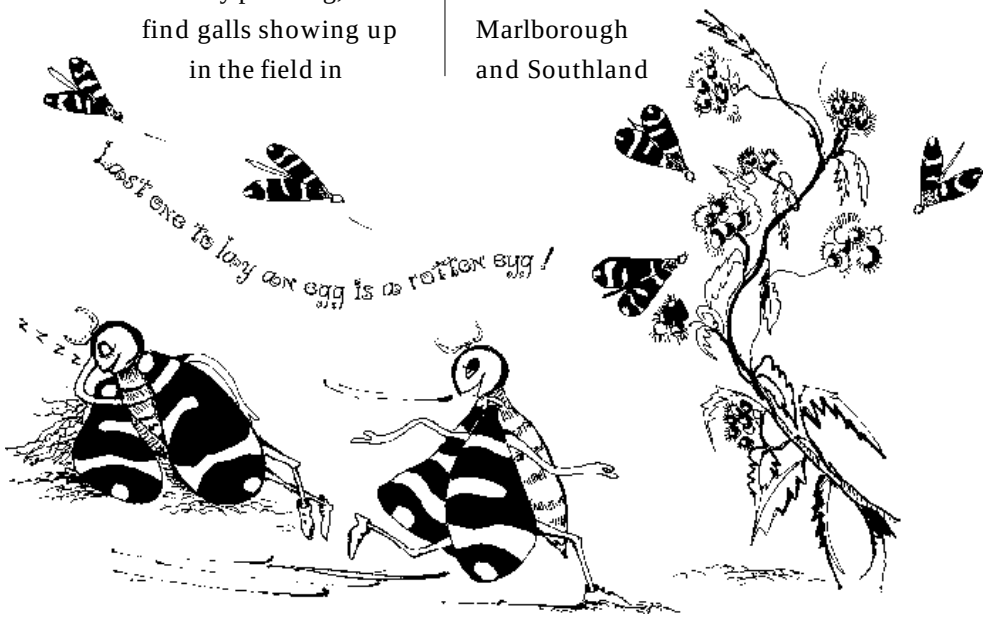
What's Inside?

Gall Flies Are Go!

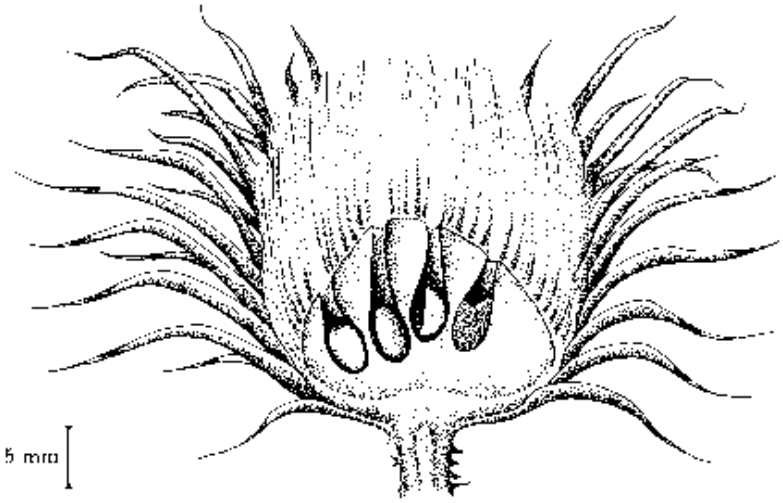
This autumn, we have been delighted with the performance of two of our newer agents, the mist flower gall fly (*Procecidochares alani*) and the Scotch thistle gall fly (*Urophora stylata*).

The mist flower gall fly was released for the first time in February and astounded its liberators by getting straight down to business. "As soon as we opened the lid the flies made a beeline for their host and began laying eggs right in front of our eyes," enthused Chris Winks. "It makes a change from having agents simply disappear into the wide blue yonder." It wasn't surprising then, but still enormously pleasing, to find galls showing up in the field in March. "With such a promising start we will be extremely surprised if the fly doesn't readily establish in New Zealand," said Chris. If you are out and about in mist flower country, keep your eyes peeled for the characteristic swellings that stunt the plant's growth.

The Scotch thistle gall fly was released in Rodney (north of Auckland) just before Christmas 1998, and more recently in Canterbury, Marlborough, and Southland. We are now confident that this seed-feeding fly is a permanent resident after finding infested flower heads for the third year in a row at Rodney this autumn. The Marlborough and Southland



sites haven't been checked yet, but a recent visit to one of the Canterbury ones (near Lincoln) revealed lots of infested flower heads; more than enough to enable harvesting to begin already. Like nodding thistle flowers infested with nodding thistle gall fly (*Urophora solstitialis*), infested Scotch thistle flower heads are easy to spot once you get your eye in. The shiny white pappus hairs remain attached to the flower heads giving them a tufty appearance, and the flower heads are hard and lumpy. Be careful how you verify the latter symptom as Scotch thistle flower heads have extremely vicious spines! The best time to check for infested flower heads is in the autumn when the plants are beginning to dry off.



Infested Scotch thistle flowerhead that has been cut in half to show the larvae inside

Tell Me More...

Question: How can I tell the three thistle gall flies apart?

The three thistle gall flies are extremely similar in size and appearance, but they can be distinguished by the markings on their wings if you can get them to sit still long enough! The Californian thistle gall fly (*Urophora cardui*) has an obvious thick black "W" on each wing. The differences between the wing markings of the nodding thistle gall fly (*Urophora solstitialis*) and Scotch thistle gall fly (*Urophora stylata*) are quite subtle (see below). The species of plant that you find the flies on is often the best quick guide. Nodding thistle gall flies prefer nodding and plumeless thistles. Scotch thistle gall flies prefer Scotch thistle but may occasionally attack Californian thistles, whereas Californian thistle gall flies tend to stick to their namesake.

Scotch thistle gall fly

Nodding thistle gall fly

Californian thistle gall fly

Hot Gossip

After several years of struggling we finally managed to rear respectable numbers of the **gorse colonial hard shoot moth** (*Pempelia genistella*). This allowed us to supply five regional councils this autumn with a shipment each of the tiny first-instar caterpillars (the stage after they hatch from the egg and before their first moult). "Providing they survive relocation, the caterpillars will feed on the foliage and grow slowly over the winter in communal webs," explained Hugh Gourlay. Come spring the caterpillars will become more active and put on a growth spurt, ending up quite large (about 2.5 cm long). Their webs also become more obvious, reaching up to about 20 cm across.

An application to release three new **hieracium** agents was lodged with the Environmental Risk Management Authority (ERMA) in January. Despite the fact that no one made a submission opposing the release of these new agents, ERMA held a public hearing in early May to allow all the issues to be fully discussed. Hopefully they will soon give us the thumbs up to release a **midge** that galls the plant (*Macrolabis pilosellae*), a **hover fly** that feeds on the roots (*Cheilosia urbana*), and another **hover fly** that feeds on the leaf axils and rosette crowns (*Cheilosia psilophthalma*).

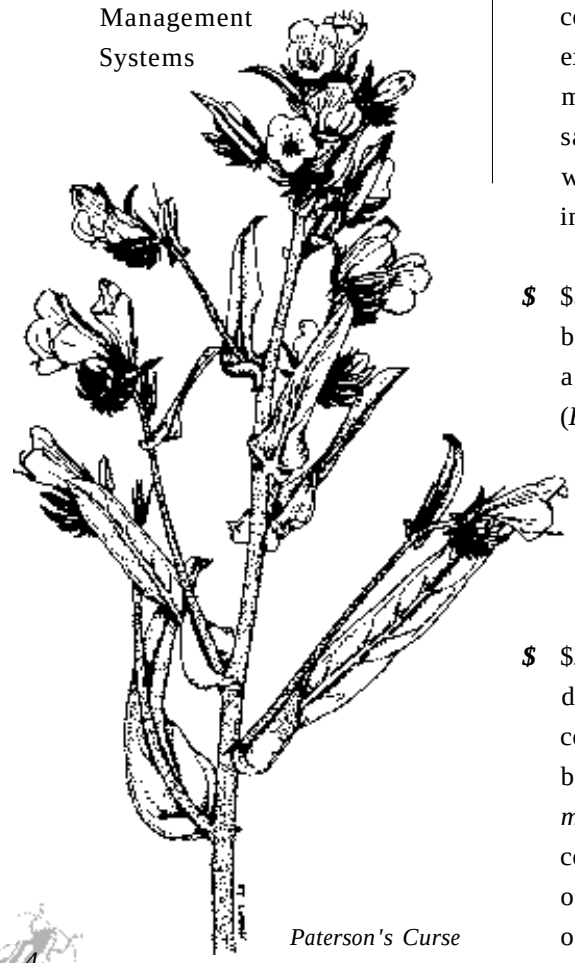
Gorse colonial hard shoot moth larvae

In February **Lynley Hayes** spent a fortnight in Australia as a guest of the Co-operative Research Centre for Weed Management Systems (**Weeds CRC**). The Weeds CRC was formed in 1995 as a joint venture bringing together Australia's best weed busters to tackle a billion dollar problem. The Weeds CRC has put out many excellent publications (see www.waite.adelaide.edu.au/CRCWMS) but felt there was a need to produce a popular summary that explains the status of its biological control programmes to all the grass roots workers who have participated in some capacity. Lynley helped to make this idea a reality by interviewing researchers at CSIRO in Canberra and Perth, the Keith Turnbull Research Institute in Melbourne, and the University of Adelaide and drafting the text. "It was really fascinating to find out what our Australian colleagues have been up to," explained Lynley. "We have a number of projects in common such as broom and thistles, but they also have some completely different ones that I was less familiar with like horehound (*Marrubium vulgare*) (see "You Ain't Nothing but A Hound Moth", pg. 5), Paterson's curse (*Echium plantagineum*) and double gee (*Emex australis*)." The finished product is expected to hit the streets around the middle of the year.

Money Talks

When the payback time for research projects is many years down the track it can be difficult to persuade the people in charge of the purse strings to stick with them, especially as our society increasingly expects instant gratification. It is soul-destroying for researchers, not to mention extremely wasteful, to pull the plug halfway through a long-term project because stakeholders have become impatient for results or have lost interest.

The Co-operative Research Centre for Weed Management Systems (Weeds CRC) in Australia has recently taken this bull by the horns and asked a group of economists to predict the potential benefits of some of their research projects. The results are astounding!



Paterson's Curse

- ***$*** $4.5 million spent on reducing weeds in cropping situations is expected to provide $124 million in benefits over the next 30 years (a 43% return on investment).

- ***$*** $2.2 million invested in developing integrated pasture management to control *Vulpia* spp. is expected to deliver $496 million of benefits over the same time frame (a whopping 62% return on investment).

- ***$*** $5.9 million dedicated to a biological control project against Paterson's curse (*Echium plantagineum*) looks likely to deliver $253 million in benefits over the next 50 years (a 45% return on investment).

- ***$*** $2.2 million spent developing a biological control project for bitou bush (*Chrysanthemoides monilifera rotundata*) could deliver $45 million of benefits (a 29% return on investment).

- ***$*** A programme to prevent Mexican feather grass (*Nassella tenuissima*) and cotton thistle (*Onopordum nervosum*) from ever becoming problem weeds looks likely to benefit the Australian economy by $83 million.

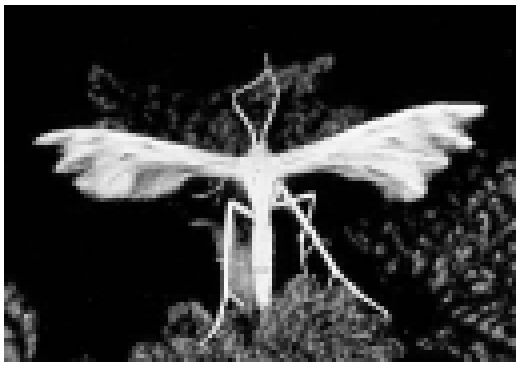
The bottom line is that well-targeted and timely research into controlling weeds can pay huge dividends in the long run. This Australian Government has recognised this in its recent decision to fund a second Weeds CRC for a 7-year term (beginning in July this year) in the face of strong competition from many other worthy contenders. Our congratulations to all involved. Landcare Research signed a memorandum of understanding with the first Weeds CRC and this time upgrades to supporting partner.

You Ain't Nothing but a Hound Moth

In New Zealand, horehound (*Marrubium vulgare*) is a plant that you often seen around stock yards, and other places that sheep tend to congregate, especially in Canterbury and Otago. However, it is not the serious weed here that it is across the Tasman.

Resourceful pioneers introduced horehound to Australia for use as a medicinal herb and for brewing beer. The plant has gone on to infest 26 million ha and occurs in all states except the Northern Territory. Southern and eastern parts of Australia are worst affected. The seeds come conveniently packaged inside sticky burrs that are easily accidentally transported about the countryside by sheep and kangaroos. A biological control programme has recently been instigated to give the plant a taste of its own medicine.

The first control agent for horehound, a plume moth (*Wheeleria spilodactylus*), was released during the mid-1990s. The caterpillar stage munches the growing tips and stems, which weakens the plant and limits flower and seed production. However, this agent did not establish well in dry areas. Studies



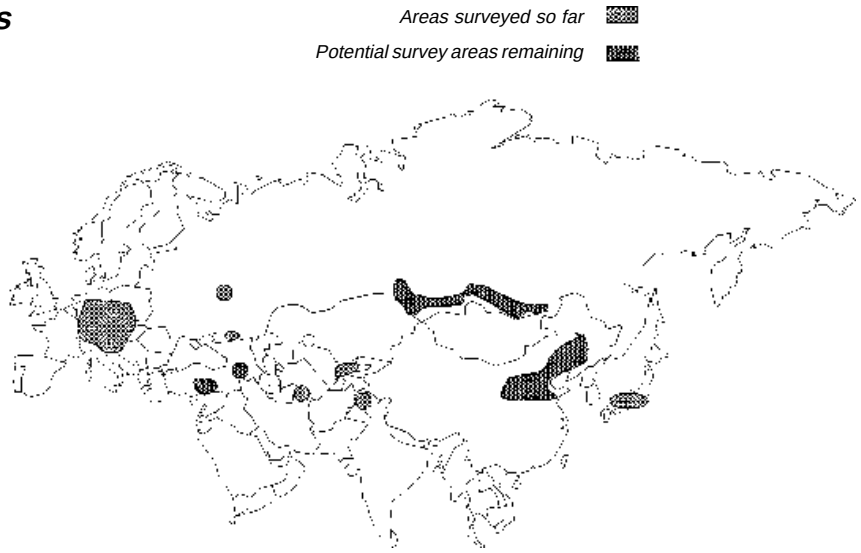
Adult horehound plume moth

revealed that the moths had become inbred and lost their special survival mechanism of hiding away during the hottest months. The problem was quickly solved by bringing in some new blood, and the moth is now well established in all areas. Craig Clarke, who studied the moth intimately for his PhD thesis, suspects that the plume moth will do best in wetter areas. "In places where the plant doesn't die back over the summer the moth can complete twice as many generations and therefore do twice as much damage, " he explained.

While it is still early days some promising results have already been achieved in South Australia. Around 800 caterpillars were released at a site near Robe 3 years ago. After only 2 years there were enough caterpillars present to safely allow 5000 to be harvested for other areas. One year later and the caterpillars had taken another quantum leap. Dean Burgoyne, of the Robe District Council, confirmed that about 50% of plants within 500m of the release site were so badly damaged that they looked like they were on the way out. "I could easily count 100 caterpillars on some plants, and that was just the big ones. I also found the caterpillars had spread at least 25 km away in an easterly direction, and were pretty thick on patches in between."

A second agent is being released that may be more adapted to the dry conditions that prevail in many parts of Australia. Clearwing moth (*Chamaesphecia mysiniformis*) caterpillars feed inside the roots and stems so they are more protected from the elements. The plant's ability to move water and nutrients around is compromised, resulting in smaller plants that are less able to cope with drought. The clearwing moth has only been released at a small number of sites so far and it is not yet known whether it has survived.

Desperately Seeking Agents



Californian thistle is not proving to be an easy biological control target by any means. So far only one of the insects released to attack the plant in New Zealand is showing any promise (see Table 1). More agents are urgently needed to add pressure to the plant and researchers are leaving no stone unturned in their search for suitable candidates.

Table 1. Insect biological control agents released against Californian thistle in New Zealand

Altica carduorum Foliage-feeding beetle	Failed to establish despite numerous releases
Lema cyanella Foliage-feeding beetle	Established at low levels at a few sites, probably not capable of having a significant impact
Rhinocyllus conicus Seed-feeding weevil	Prefers nodding thistle but will also attack Californian thistle (and other thistles) to a lesser extent
Urophora cardui Gall-forming fly	Appears to be establishing in New Zealand. Capable of stunting plant growth, but no impact seen yet
Urophora stylata Seed-feeding fly	Appears to be establishing on Scotch thistle, may attack Californian thistle slightly

Casting the net widely

Californian thistle occurs naturally in Europe, western Asia, and northern Africa. It also grows under a wide range of environmental conditions, which means there are lots of places out there where potential biological control agents might be lurking. However, many of these places have not until recently been (or still aren't) safe or easy to visit. The best places still left to look for agents for New Zealand (eastern Turkey and the Caucasus Mountains) will be some of the most difficult tackled so far, if they can be surveyed at all (see Map).

Over the 40 years that researchers have been looking, quite an array of insects have been found to hang out on Californian thistle. Unfortunately, the vast majority have turned out to be not sufficiently host specific, not damaging enough, or difficult to work with. Specificity is particularly critical for agents intended for areas like North America that have native thistles to contend with. Experience has also shown that, with its extensive underground rhizomes the plant is quite hard to knock back and is not too troubled by a bit of damage to its leaves. Researchers are now focussing their attention on finding potentially more harmful root and stem feeders that may have the added bonus of allowing naturally occuring pathogens to gain entry to the plant.

Table 2. Where have researchers looked so far?

1960–65	southern England, France, southern Germany, Switzerland, Austria, northern Italy, northern part of former Yugoslavia
1972	north-eastern Iran, northern Pakistan, Japan
1990–93	Germany, Austria, Poland
1997	northern Germany, Poland, Czech Republic, Slovakia
1999	southern Russia
2000	Uzbekistan

André Gassmann, of CABI Bioscience, Switzerland, is leading a team of researchers who are currently searching for new agents on our behalf. Unfortunately André's team have not unearthed anything special or exciting so far in southern Russia or more recently in Uzbekistan. Almost 85% of Uzbekistan is desert or semi-desert and the thistle tends to grow in cultivated, irrigated areas. Compared to other areas the insect fauna seemed to be slightly impoverished here. The most likely centre of origin for Californian thistle (and where you might expect to find the richest associated fauna) is now believed to be in the Caucasus.

Nine species of insects currently feature on the list of possibilities requiring further research (Table 3). If none come to fruition, then it may be necessary to fall back on a mycoherbicide approach. There are a number of different pathogens being studied around the world with this end in mind (see Issue Number 15 of this newsletter).

Table 3. Potentially useful insects that warrant further investigation

Aceria anthocoptes Gall-forming mite	Potentially very specific and damaging, common in the Balkans
Altica carduorum Foliage-feeding beetle	May be better strains available in China
Apion onopordi Root-feeding weevil	Can vector the fungus *Puccinia punctiformis*, but the weevil is uncommon in native range
Cheilosia sp. Stem / root-boring fly	Potentially host specific, but may not be especially damaging and is difficult to rear
Corythuca disticta Sap-sucking lace bug	Insect native to the USA, where it has been distributed to a small extent as a biological control agent
Dyaphis lappae Root-feeding aphid	Recorded from Denmark, warrants further study
Euhagena palariformis Root-boring moth	Potentially very host specific, but proving difficult to collect in Turkey
Lixus elongatus Stem-boring weevil	May not be particularly damaging, but a close relative, *Lixus cardui*, has proved useful against *Onopordum* in Australia
Thamnurgus sp. Root-boring beetle	Potentially damaging, but taxonomy is uncertain and proving difficult to collect in southern Russia

Lessons learned

The only agent showing any promise in New Zealand, the Californian thistle gall fly, has only been released in a few places and there is still a lot of scope for increasing its distribution. Last year eight farmers / regional council staff in the Otago / Southland area again attempted to rear gall flies in special cages outdoors. The idea was that they could bulk up the number of flies and get them more widely established faster than if the flies were left to their own devices. Even with a tried and true recipe to follow, and a year's experience under their belts, there were still a lot of traps for young players (Table 4). This has meant that the cage rearing has not yet realised its true potential.

Jason Miller, farmer; Simon Fowler; and Grant Catto, Californian Thistle Action Group chairman, assess the success of this year's Californian thistle gull fly rearing. Photo: The Southland Times.

Table 4. Difficulties experienced rearing Californian thistle gall flies in field cages and how to overcome them

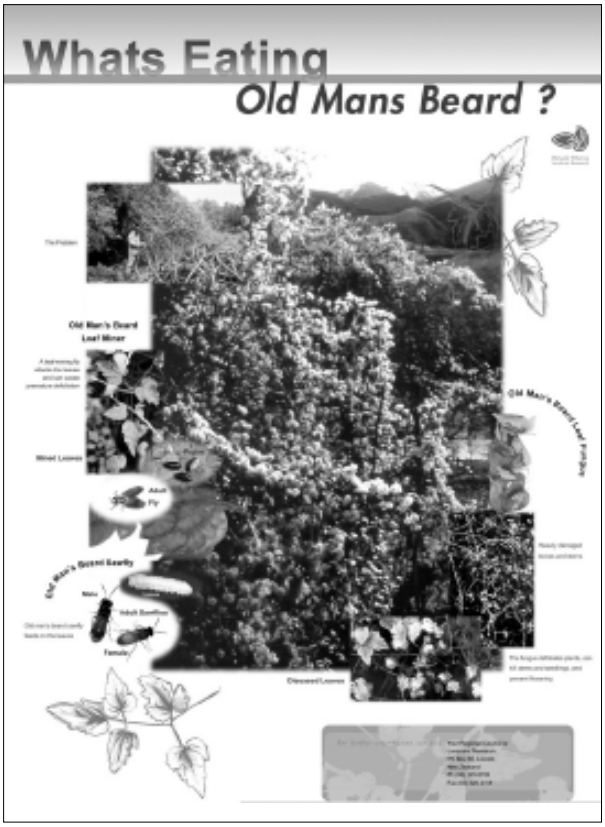
Problem experienced	**Solution**
Galls kept in the fridge over winter were not kept moist enough (it doesn't matter if they go mouldy), which meant that the flies emerged too late in the season	Hang galls in wire cages in the shade outside (close to their host plant) to allow the galls to break down sufficiently and the maggots to complete development
Wind damage to cages allowed some flies to escape	Design and build stronger cages. Also fence off a corner of a paddock for the rearing cages so any flies that escape can attack plants *outside* the cages (as happened at one site)
Stock ate galls	Use fine wire mesh to protect the galls once the rearing cages are removed
Extreme drought may have affected plant (and hence insect) development in some areas	Try watering thistles if the season is drier than usual

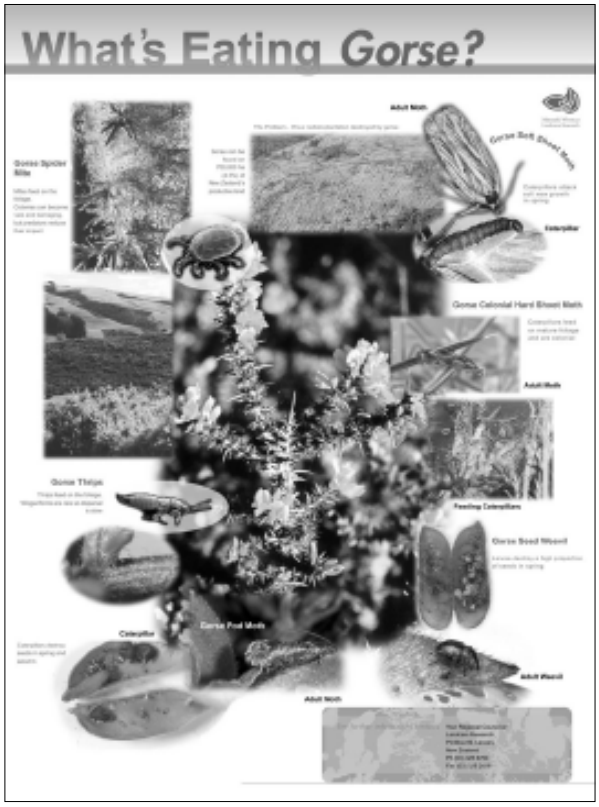
These lessons, learned the hard way, remind us that rearing insects is often not easy — even trained entomologists find it hard at times! Hopefully, most of the difficulties have now been ironed out and it will be third time lucky for these dedicated souls and they will be amply rewarded for their perseverance in years to come!

This project is funded by The Californian Thistle Action Group which successfully gained a 3- year grant from the Agricultural and Marketing Research and Development Trust (AGMARDT) in 1999.

Posters Galore!

Recently we have been busy preparing some new display material and revamping some of our older stuff. This means that a selection of colourful new posters are now available to brighten up your office or pull in the crowds at field days (see below).





Contact Lynley Hayes (hayesl@landcare.cri.nz or Ph 03 3256 701 ext 3808) if you wish to place an order. Don't forget that the video "Natural Born Weed Killers", featuring a cast of millions, is also still available to help you to wow audiences and educate people about biological control of weeds.

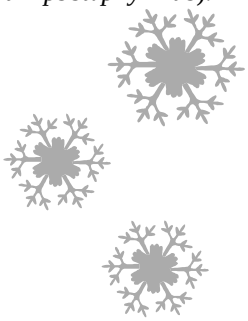
Poster	A0*	A1*	A2*	A3*
What's Eating Gorse?	$100	$75	$50	$25
What's Eating Nodding Thistle?	$100	$75	$50	$25
What's Eating Old Man's Beard?	$100	$75	$50	$25
What's Eating Ragwort?	$100	$75	$50	$25
Snakes and Ladders (a humorous yet realistic insight into what's involved in developing biological control programmes)	$100	$75	$50	$25

* A0 = 840 x 1190 mm, A1 = 594 x 841 mm, A2 = 420 x 594 mm, and A3 = 297 x 420 mm
All prices include GST.

Winter Activities

Winter is the time when many people can have a bit of a breather on the biological control front. The end of May is often the cut-off time for harvesting ragwort flea beetles (*Longitarsus jacobaeae*), although it may still be possible to collect them in good numbers in warmer areas throughout winter. Nodding thistle crown weevils (*Trichosirocalus horridus*) can usually be shifted around 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. The weevil also attacks cotton, marsh, plumeless, Scotch, slender-winged and winged thistles so look out for damage to these plants too.

Remember to use the winter time to make plans for the coming spring, and get up to date on the paperwork. If you have any outstanding release or recovery forms, then please send them in without delay so we can ensure our nationwide databases remain as up to date as possible. Also 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*).



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Manaaki Whenua. Manaaki Tangata:
Care for the land. Care for the people