Biological control of exotic pasture weevil pests in NZ: learning from experience to inform the future

Mark McNeill, Barbara Barratt, Colin Ferguson, Pip Gerard, Stephen Goldson, Scott Hardwick, John Kean, Craig Phillips, Derrick Wilson

AgResearch, Biocontrol and Biosecurity

agresearch

B3 Science Solutions for BETTER BORDER BIOSECURITY www.b3nz.org

Biological invasions and biocontrol

Sitona discoideus

Listronotus bonariensis

Sitona obsoletes

agresearch

Sitona discoideus (lucerne weevil)

Argentine stem weevil (ASW)

- ASW (*L. bonariensis)* was accidentally introduced to New Zealand in the early 1900s
- Significant pest of several economically important graminaceous plants including ryegrass, cereals, maize, sweetcorn
- Population in New Zealand relatively homogenous
- RAPD analysis showed that probably originated from Uruguay/Argentina
- Observe relict diapause behaviour in New Zealand

Clover root weevil (CRW)

- Found December 1995/ Identified March 1996
- Strong preference for white clover species, - few natural enemies, - plentiful food, more than one generation/year
- Adults feed on leaf, larvae feed on nodules and roots
- Can destroy up to 100% of nitrogen fixing nodules
- All life stages present all year round,
- Estimated yearly losses of $200M to $1 billion if left uncontrolled

Introduction summary

- As part of integrated pest management strategies, biological control of these weevil pests has been shown to reduce pest impacts, and crucial to raising the profile of biological control amongst farmers
- Uncomplicated ecosystem very good for examining biological and evolutionary processes
- The emerging issues of climate and land use change, the role of endosymbionts in arthropod biology and phasing out of several insecticides will have impacts on biological control that are as yet relatively unexplored.

agresearch

Why are they a problem?

- Invasion into a pristine environment – free of natural enemies
- A largely untapped resource – achieve plague proportions

- Classical biological control has been critical
- (plus plant resistance and farm management strategies)

Show me the money

- Impacts of these pests on productivity and persistence
- Economic costs vs benefits of biocontrol
- Need to understand the biology of the pest
- Establish thresholds – easier said than done

Three successful (?) biocontrol introductions

Microctonus aethiopoides (Moroccan)

Lucerne weevil

Microctonus hyperodae

Argentine stem weevil

Microctonus aethiopoides (Irish)

Clover root weevil

Successful biocontrol introductions

$5 M pa saved

$280 M pa saved

$300 M pa saved

Moroccan *M. aethiopoides* (against *Sitona discoideus*)

- Introduced in 1982
- Minimal testing
- Wide host range in NZ

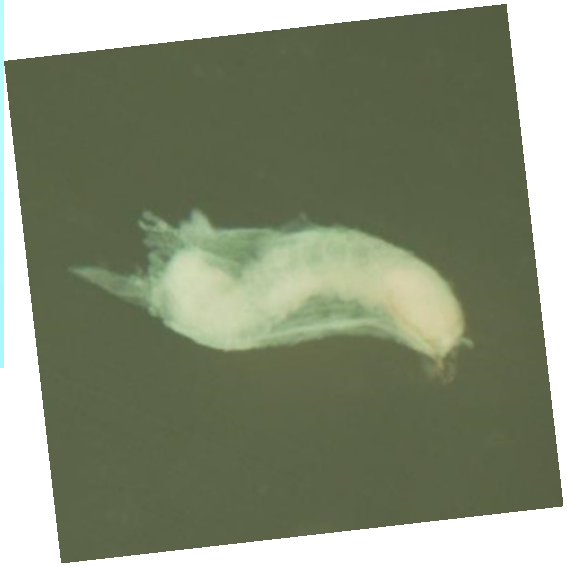
agresearch

Microctonus hyperodae (against ASW)

- Thelytokous, solitary endoparasitoid
- Eight South American geographical populations comprised two biotypes.
- West of the Andes (Chile)
- East of the Andes (Argentina, Uruguay and Brazil)
- Introduced 1991
- Multiple research and commercial release to 1998

Microctonus aethiopoides x CRW

- Found to be the main parasitoid species attacking CRW in Europe. Strains either arrenotokus or thelytokous (Ireland)
- Released biotype from four locations in Ireland (2 haplotypes) (thelytokous strain)



Highlights of the research

- Virus like particles
- Identification of ecotypes/ biotypes by DNA, isozymes and morphometrics
- Enhancing the impact of biological control
- Parasitoid diapause behaviour
- Modelling impacts
- Parasitoid reproduction and discrimination
- Strain interactions
- Non-target impacts (relative attack rates, immune responses)
- Endosymbionts

agresearch

Highlights of the research

- Virus like particles
- Identification of ecotypes/ biotypes by DNA, isozymes and morphometrics
- Enhancing the impact of biological control
- Parasitoid diapause behaviour
- Modelling impacts
- Parasitoid reproduction and discrimination
- Strain interactions
- Non-target impacts (relative attack rates, immune responses)
- Endosymbionts

agresearch

Weevil warmers

Parasitoid reproduction and discrimination

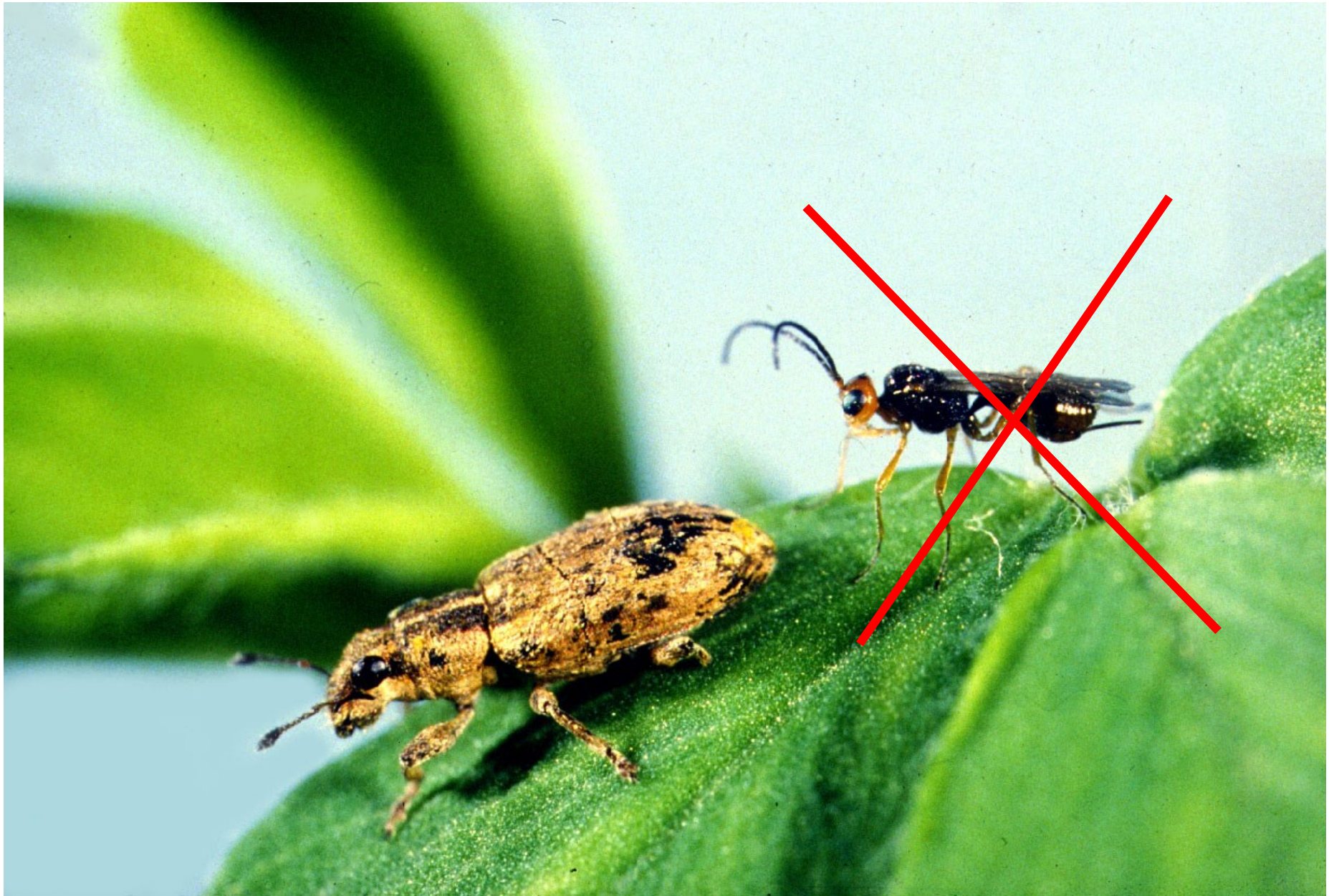
Species/ strain	Host	Reproduction		Discrimination score
M. hyperodae	ASW	thelytokous	solitary	0.2
Microctonus aethiopoides				
Ireland	CRW	thelytokous	gregarious	2.0
Wales	CRW	arrenotokus	solitary	1.0
Moroccan	lucerne weevil	arrenotokus	solitary	0.6 (water)
				0.3 (sucrose)

agresearch

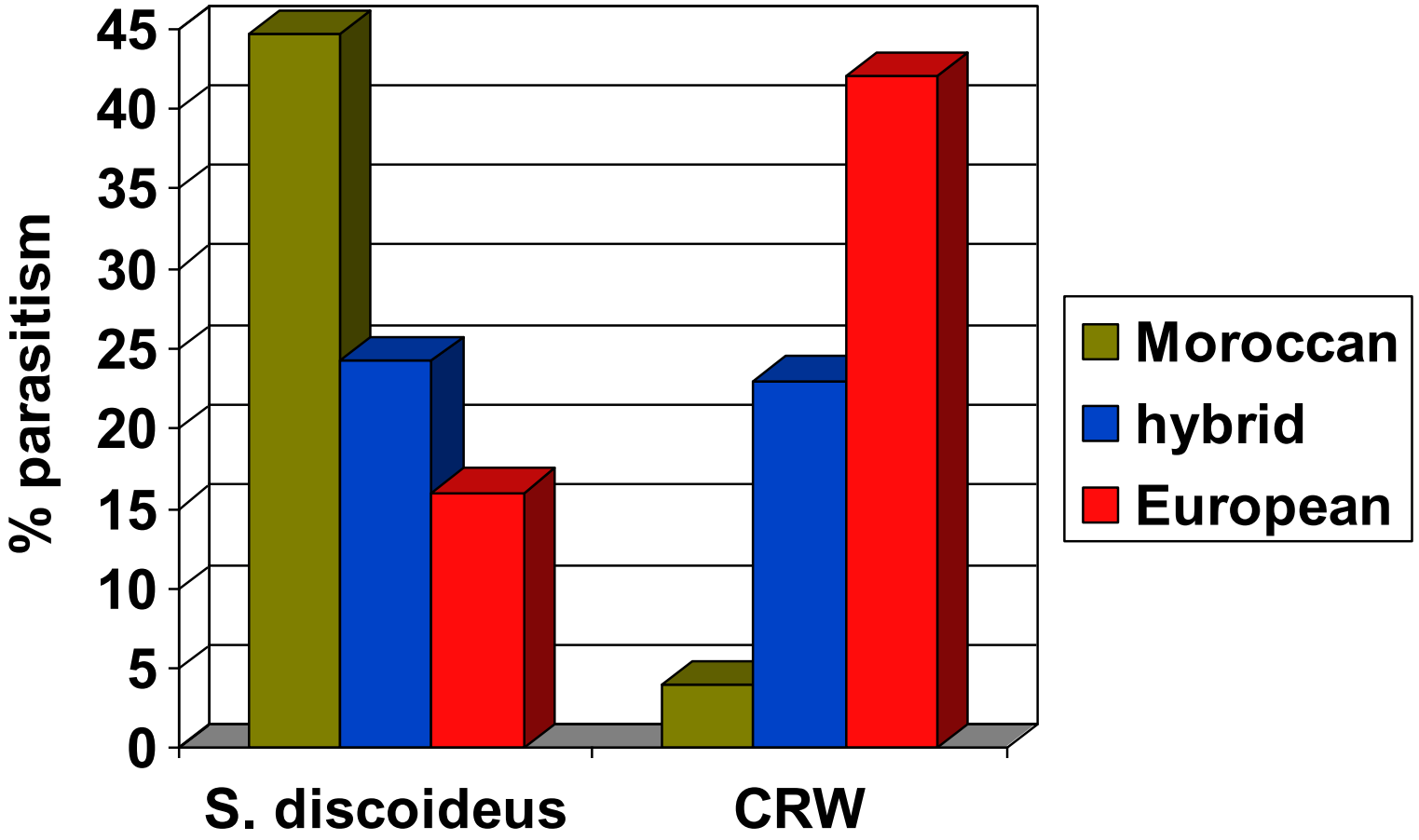
Risks of competing parasitoid strains

- Moroccan strain attacks *Sitona discoideus*
- Would Moroccan strain attack CRW ?
- Interaction with arrenotokus strains of European *M. aethiopoides* ?

It didn’t work against CRW



Parasitoid hybrids (Moroccan x European) less effective



agresearch

Non-target research (IQ)

- Taxonomic relationships
- (Wapshere's centrifigal phylogenetic testing)
- Shared biomes (target and non-target weevil)
- Phenological overlap
- Native weevils/ Beneficial BCA's
- Moroccan *M. aethiopoides* host range also provided candidate weevils

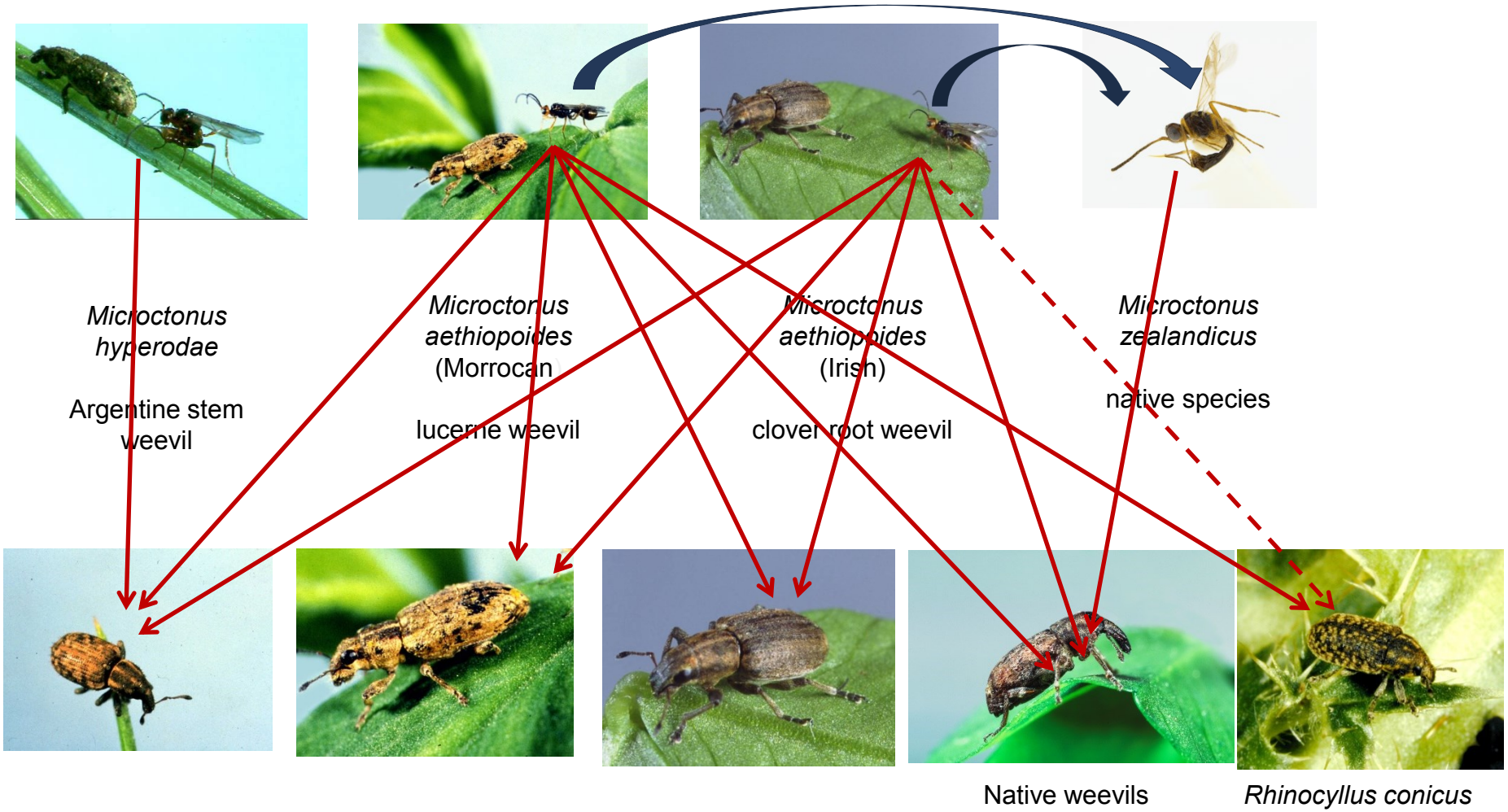
Non-target parasitism by *M. aethiopoides* (field)

Canterbury – Hilltop

- Parasitism of *I. aequalis* by Irish biotype – predicted
- Parasitism higher than for CRW – contrary to predictions

  e.g. winter 2012 92% *I. aequalis* c.f. 22% CRW
- Parasitism of *I. aequalis* from both Moroccan and Irish
- Parasitism by 2 biotypes may be additive
- Don't know if ether introduced species displaces *M. zealandicus*

The solutions - the relationships



agresearch

B3 Science Solutions for BETTER BORDER BIOSECURITY www.b3nz.org

Moroccan *M. aethiopoides* against CRW

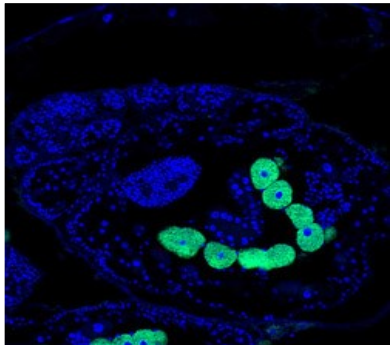
Why was it unable to successfully develop in CRW?

Endosymbionts

- Preliminary work indicated the presence of endosymbionts in CRW
- Obligate (primary) or facultative (secondary)
- Influence the ecology, biology and evolution of the host

Facultative or secondary endosymbionts

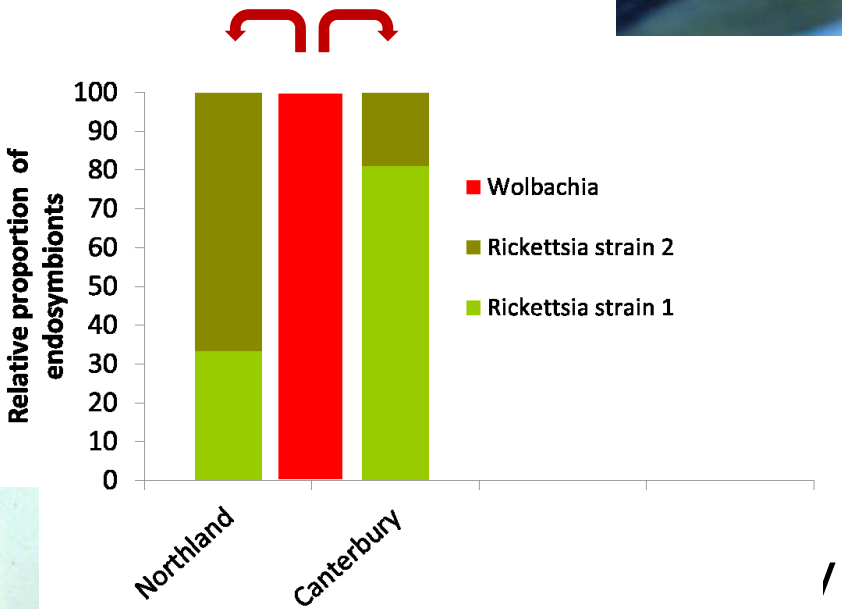
- Presence can be neutral, beneficial or detrimental to the host
- Can play role in host defence against parasitoids
- Include *Wolbachia, Rickettsia, Cardinium, Spiroplasma, Hamiltonella, Regiella* and *Serratia*



agresearch

CRW infections

Northland



Climate change

- Warming will open up opportunities for new crops
- Associated pests and diseases
- Movement of insect pests and associated BCA's into new ranges
- Increase opportunity for invasive species to establish. New problems

- Displacement of existing BCA's
- Impact on host-parasitoid relationships

Important to deliver

- There has got to be measurable benefits to the industry
- Spread the word
- Research demonstrates that benefit
- Farmer and industry support critical

Promoting the message

THE DOMINION POST

BusinessDay

BEST BUSINESS SECTION — QANTAS MEDIA AWARDS

THE DOMINION POST, SATURDAY MAY

Hudson

jobs.hudson.com

THE $2b BUG

A clover-chewing weevil threatens the livelihood of North Island farmers.

Jon Morgan reports.

IT IS news farmers have been dreading — the clover root weevil is firmly entrenched in the lower North Island. How bad is this bug, so tiny it can hardly be seen by the naked eye?

Keith Holmes' view would shock most farmers: "I would rather have foot-and-mouth disease than the clover root weevil," the Waikato dairy farmer says. "Foot-and-mouth would be terrible, no doubt about it, but the public and the Government would rally round and eventually life would return to normal.

"But the weevil is with us forever — its damage is ongoing and will be many times more than the $10 billion a foot-and-mouth outbreak will cost."

The weevil, a European native that is believed to have sneaked past border controls more than 10 years ago, has found paradise in New Zealand.

It attacks white clover above and below ground, destroying the nitrogen-fixing pasture plant long regarded as the rock on which the economy is built.

'I would rather have foot-and-mouth disease than the clover root weevil. Foot-and-mouth would be terrible,

The benefit of white clover is estimated at $3 billion a year, giving New Zealand a competitive edge in overseas markets.

Mr Holmes, who has battled the weevil since it was first found in Waikato in 1996, believes it reduces nitrogen fixation by two-thirds and, if farmers do nothing to redress this, the cost to the economy will be $2 billion a year.

tale bite-marks in their clover and are not sure how to deal with it.

Mr Holmes, a member of the Waikato Clover Management Group of dairy farmers affected by the weevil, says he is annoyed that it has been left to people like him to travel the North Island to speak at farmer meetings.

His message is blunt: "If you don't do something about the clover root weevil, you are going to have 30 per cent less production. It is here, it is spreading, but you can farm with it. It will cost you a lot of money — get used to it."

Waikato farmers want to save others the years of trial and error they went through to find the best ways to cope with the weevil. They warn of "quackery" and misinformation about fertiliser alternatives.

Mr Holmes says many farmers are fooled because they see the clover still there in the field. But it is not fixing nitrogen because the weevil's larvae have eaten the underground nodules and roots.

For dairy farmers, applying synthetic nitrogen little and often is the best way, but if they do not start as soon as they see leaf damage, the nitrogen stored in their soil will run out and much more will have to be applied to get levels back up.

Not enough farmers have attended meetings in Hawke's Bay and Mr Holmes worries whether he has struck the same

'They say they don't have the clover weevil, or they had it once and it is gone now. But it never goes — if you have clover you have the weevil . . . it's as simple as that.'

Bernard

COMM

I'm n alone in be cheap

I DID an un couple of mo money. I bou washer for abou the cheapest Fish

It was on spe hard to find becau have agreed with not to stock the products, but it w

It got me thi long-term future biggest-exporting an era when low- Korean rivals hu ed markets to dor purchase finance

The task is eno

Fisher & Payk already struggli lar and expensiv Profits fell 20 per $68.6 million and those profits car

It is reminisc General Motors, more money fro sales than from

Fisher & Payk profit on each and that's befor and tax. That's trade deals start and Koreans get

Fisher & Payk ting a taste of t

THE DAILY NEWS

THURSDAY F

Editorial — Avalon Willings Phone

de in hell for stem weevil

FATAL ATTRACTION: Paul Addison releases the first batch of Argentine stem weevil impregnated with the eggs of a parasitoid wasp, as farm owner John Wells (centre) and project leader Terry Richardson look on. PHOTO: MAARTEN HOLL

STEPHEN GOLDSON: Stem weevil resembles a ball bearing and is just as tough. PHOTO: RUSTY RITCHIE

staggers, facial eczema and bloat) brought about by changes to pasture quality.

It all adds up to the fact the Argentinian immigrant is one of New Zealand's most costly insect pest. In Taranaki, it is estimated the average farm is home to about 70 million stem weevils, yet many farmers are unaware of its presence.

But Lincoln-based scientist and Argentine stem weevil biological control programme leader Dr Stephen Goldson, who was in Taranaki last week, says that's hardly surprising.

While the larvae hide inside plant stems, their parent is well camouflaged by the soil. Any damage to pastures is not usually apparent until about a fortnight after the larvae have attacked and left the plant.

But it is the wasp's detective kills which make it such a force to be reckoned with.

"We've found this one is a very good searcher and is very good at finding the weevil — that's the key. It's very systematic. It specifically looks for an empty weevil and knocks it off."

It is the stem weevil's elusive nature which has made it difficult to target successfully with pesticides, says Dr Goldson.

"It lays its eggs on the grass stem and the grub drills outwards and kills the grass. But because they live inside the stem it's been very difficult to get spray on it. It is very difficult to control and very difficult to see."

That, says Dr Goldson, left two approaches in reducing the pest's population — the first, sowing high endophyte grasses which provide limited resistance to the weevil.

Trials have shown that dairy farmers could experience losses of up to two litres of milk per cow per day when grazing high endophyte pasture during the three months of January, February and March.

Lamb liveweight gains on nil-endophyte ryegrasses have been shown to be 30% greater than those grazed on high endophyte pasture. In fact, high endophyte grasses have now been banned in Britain after horses reportedly contracted staggers from being fed straw from a New Zealand variety of ryegrass.

Dr Goldson says the better option is biologically controlling the pest which will then enable farmers to sow low endophyte grasses and lift their production.

Along with a team of four or five others he has been working on the biological control programme since 1989 when he went to South America in search of the parasitoid.

Until now, the evil weevil has lived a trouble-free life in an environment where it has had no natural predator to worry about.

"We brought the wasp over without any of its own natural enemies so when we did release it, it had a fairly good go — rather like the stem weevil has over the years. All we've done is reset the balance of nature.

"We spent a year and a million dollars making sure it attacked only the weevil and that it wasn't going to wipe out anything else."

And Dr Goldson says the programme is user-friendly.

"There's the environmental considerations. The parasite means we can get away from using pesticides and we may also be able to reduce the frequency of cultivating pastures, which will preserve soil erosion."

But the work is by no means finished.

"It's great to see Taranaki farmers getting behind this so when new information comes out they're ready to grab it instead of sitting on their hands.

"It will have a big role in pasture production from now on."

The release yesterday involved wasps which had already been impregnated by the parasitoid wasp.

AgResearch entymologist Paul Addison (Hamilton) said the weevils would live for about three weeks until the parasitoid bored its way out of its host. The wasp would then go into a cocoon stage for between a week and 10 days then emerge as an adult to start over again.

The parasitoid in Taranaki is expected to produce four generations a year.

Dr Addison said farmers could expect to see changes in their pasture within five years.

"It's going to take a while until the situation stabilises and most districts are covered."

The parasitoid has been released in several sites in the Waikato and Bay of Plenty. Wasps from the initial release in 1991 now covered a radius of 20km.

Mr Richardson said that by next autumn the parasitoid will have been released on 40 properties in Taranaki. Once the farm field trials have been established, field days for other farmers will be organised.

What is Argentine stem weevil costing you in terms of pasture persistance and stock health and performance?

AgResearch has a

CLEAN, GREEN BIOLOGICAL CONTROL AGENT

to assist you

For further information contact:
Francis Pauwels
AgResearch,
P. O. Box 60, Lincoln
Phone 03-325-6900 Fax. 03-325-2946

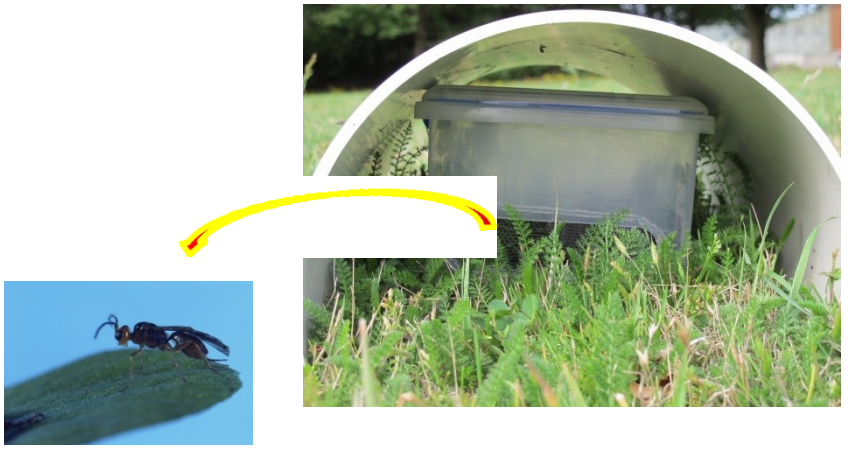
AgR AgResearch

New Zealand Pastoral Agriculture Research Institute Limited

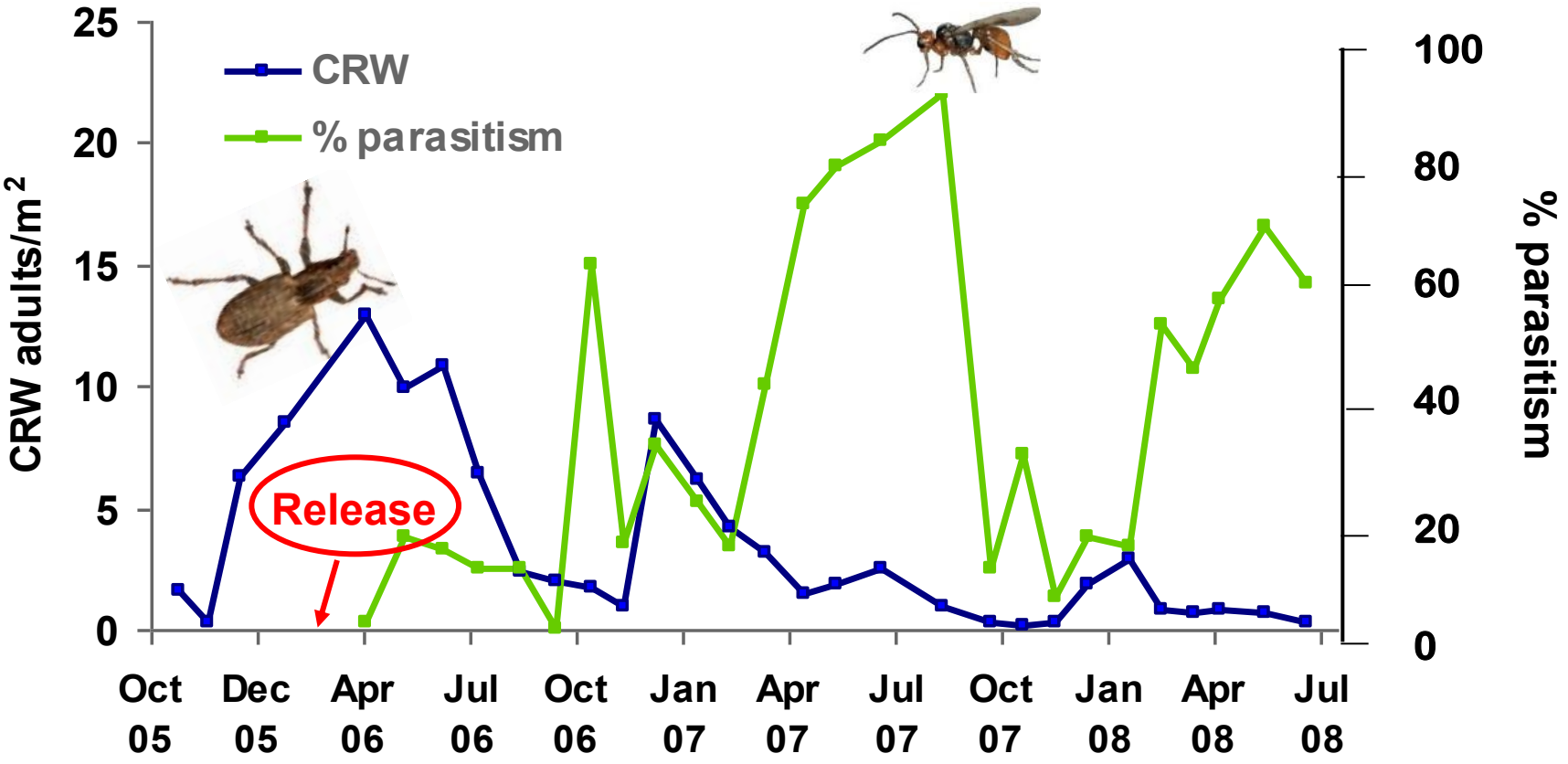
Release strategies

- **Standard release of parasitised CRW (1000-2000 parasitised weevils)**
- **Nursery sites**
- **Giveaways (ration packs of 10 or 100 parasitised weevils)**

- **Use of selective emergence cages**



Parasitism in CRW population: Hawke's Bay



What have we learnt

- Support is critical to success
- Do your homework
- Think long term – beyond release
- Integrated research teams
- Be prepared for new pests

~120 species of *Hypera*

~100 species of *Sitona*