7.6 The abundance and distribution of beneficial predators to achieve Integrated Pest Management (IPM) in crops and pasture

Location:
13 sites with 100 km of Geelong

Funding:
Grain and Graze

Researchers:
IPM Technologies Pty Ltd (Dr Paul Horne, Jessica Page, Neil Hives)
Agvise Services (Steve Dickson, David Watson)
Department of Sustainability and Environment (Jaimie Mavromihalis, Vivienne Turner)

Authors:
Cam Nicholson, Grain and Graze Regional co-ordinator, 0417 311 098
Dr Paul Horne, IPM Technologies, 0419 891 575

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Mt Hesse, David Kininmonth
Strathleigh, Robert Meek
Warrambeen, Ian Taylor
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Rainfall:
Not applicable

Summary of findings:
Thirty paddocks were monitored in the Geelong district to determine the diversity and abundance of two insects (carabid beetles and native earwigs) known to play a critical role in an integrated pest management program (IPM).

Forty per cent of all pasture and cropping sites had little or none of these beneficial species present. Of the sites where adequate populations of carabid beetles and earwigs were found, cropping paddocks were dominated by one subspecies of carabid (*Rhytisternus)* and the beneficial native earwig *(Labidura truncate)*. In contrast, the pasture paddocks were dominated by a different subspecies of carabid beetle (*Promecoderus).* This suggests the environment created in crops and pastures are favourable for significant increases in the population of certain beneficial species, to the extent thought to be sufficient to achieve the biological component of an IPM program.

Remnant native grassland contained a greater diversity of important carabid beetles but in numbers insufficient to provide direct biological control in adjacent crop and pasture paddocks. However the diversity of resident population means these sites play an important role as a reservoir of beneficial insects to repopulate crop and pasture areas. Most of the 'native' sites on farms were dominated by annual exotic weeds and contained beneficial populations similar to improved pasture rather than remnant native vegetation. This would

suggest native vegetation may not provide the repopulation pool found in remnant native grasslands.

Background to the trial:
Integrated pest management (IPM) is not widely adopted in broad acre cropping and grazing in South West Victoria. Recent conventional control has involved using broad spectrum insecticides or baits, generally in response to minimising current crop damage or to safeguard a crop or pasture against possible future attack. Unfortunately this often kills beneficial insects or mites that could provide biological control within an IPM program.

While insecticide spraying continues to be common practice, there is a growing interest in IMP. This interest is driven by a number of concerns such as chemical costs, a fear of creating insect resistance, operator safety issues and the gradual withdrawal of insecticides from the market.

Previous work conducted by IPM Technologies has demonstrated that beneficial insects such as carabid beetles, predatory mites, native earwigs, lacewings, ladybirds and wasps are capable of reducing or eliminating pest damage if they are present in sufficient populations and at the right time. However it was unclear how widely these beneficial species were distributed across the region, in what proportions and if there was a difference in populations between crops, pastures and native vegetation.

The aim of the studies was:
- to gain an indication of the distribution of some beneficial species across the region.
- to gain an appreciation of what beneficial species occur in the different ecosystems
- to investigate the potential role of native grasslands in assisting to control pests in agricultural crops and pastures

Trial design and inputs:
Four different vegetation types or grassy ecosystems were studied. These were:
- Winter crops such as wheat, barley and canola.
- improved pasture
- ‘native pasture’ as identified by the participating farmers,
- remnant native grassland, which has had minimal disturbance through cultivation or grazing.

A selection of carabid beetles and earwigs were chosen for analysis. These are regarded as key species that prey on many common agricultural pests.   All carabids (beetles in the Family Carabidae) are commonly known as ground beetles and they have an easily recognizable shape (photo 1). The five carabid species were chosen because they were known to be abundant from at least some sites previously sampled and because they are either predators or scavengers and eat a wide range of soft-bodied prey such as caterpillars, aphids, earwigs, slugs and possibly mites.

Photo 1: Carabid beetle

Five species of carabids were selected for this study. These species have not been the focus of any applied research until now, and they do not have any common names other than “carabid beetle”. The five species used in the study were:

1. *Rhytisternus liopleurus*
2. *Notonomus gravis*
3. *Geoscaptus* species
4. *Sarticus* species
5. *Promocoderus* species

Two earwig species were also observed. The native earwig (*Labidura truncate)* which is a predator and the European earwig *(Forficula auricularia)* a know pest in canola (Photo 2).

Photo 2: European earwigs (female top, male bottom)

Samples of these insects were collected by pitfall trapping. Collections were more often made in spring and autumn with reduced collections in the colder winter months. The number of collection sites and period of sampling is presented (table 1).

Table 1: Sample sites and period of collection

Ecosystem type	**Property**	**Dates Sampled**	**No. of Samples**
Improved pasture	*Barwonleigh*	04/05 – 05/05	4 (not continued)
	Emily Park	04/05 – 04/06	44
	Glenfine	04/05 – 05/05	4 (not continued)
	Leighview	04/05 – 06/06	22
	Mt Gow	04/05 – 06/06	21
	Mt Hesse	04/05 – 06/06	23
	Plains	03/05 – 09/05	8
	Strathleigh	05/05 – 09/05	3 (not continued)
	Warrambeen	04/05 – 06/06	12
	Woolbrook	04/05 – 05/05	5 (not continued)
Crop	*Barwonleigh*	04/05 – 05/05	4 (not continued)
	Glenfine	04/05 – 05/05	4 (not continued)
	Leighview	04/05 – 10/05	14
	Plains	02/05 – 09/05	14

	Mt Gow	04/05 – 10/05	12
	Mt Hesse	04/05 – 11/05	15
	Strathleigh	06/05 – 06/06	9
	Warrambeen	04/05 – 05/05	4 (not continued)
	Woolbrook	04/05 – 05/05	4 (not continued)
'Native' pasture	*Barwonleigh*	04/05 – 05/05	4 (not continued)
	Emily Park	04/05 – 04/06	44
	Glenfine	04/05 – 05/05	4 (not continued)
	Leighview	07/05 – 10/05	4
	Mt Gow	04/05 – 06/06	22
	Mt Hesse	04/05 – 06/06	23
	Warrambeen	04/05 – 06/06	13
	Woolbrook	04/05 – 05/05	4 (not continued)
Remnant native grassland	Shelford (roadside)	03/05 – 06/06	23
	Ballan (roadside)	04/05 – 04/06	44
	Creswick (roadside)	04/05 – 04/06	44

Collections were made by Agvise Pty Ltd and IPM Technologies Pty Ltd between March 2005 and June 2006. The insects were preserved in alcohol and the numbers of each species were counted in the laboratory.

Samples were initially collected from a large number of sites. However at some sites low or no populations of beneficial species limited the value of collecting ongoing data. While the initial samplings provided some insight into the distribution across a number of farms, continued sampling was focused on a smaller number of sites where there was a prospect of obtaining adequate numbers of key beneficial predators to draw additional conclusions. Carabid beetles and native earwigs captured over a 12 month period were used to compare sites, as previous research has indicated the "year catch" (ie the total insects captured in 12 months) is a good measure of the carabid beetle and earwig populations. Sites were compared on this basis.

Trial results:

The initial collections revealed 40% of the cropping and pasture sites had very few or no beneficial species present. The possible reasons for this result are presented in the discussion section. A total of 19 sites were selected for ongoing monitoring.

When interpreting the results it is important to consider both the number of insects collected and the relative proportion of each species in the total catch.

The results show the relative proportion of each carabid subspecies captured varies depending on the ecosystem present. The remnant native grassland contained four of the five carabid subspecies, although not all species were present at each site. (Figures 1 & 2). Species *Promecoderus* was recorded at each site and in reasonable proportions (between 30% and 60% of the total catch). However the total number of species was low in contrast to collections from the pasture and crop paddocks. The remnant native grassland sites had a fraction of the total of any key species found in crop or pasture habitats. For example one remnant grassland site at Shelford had a total catch of 35 carabid beetles and earwigs compared to a total catch of 364 carabid beetles and earwigs in the neighboring cropping paddock.

Figure 1: Relative abundance of beneficial species (all roadside remnant native grassland sites)

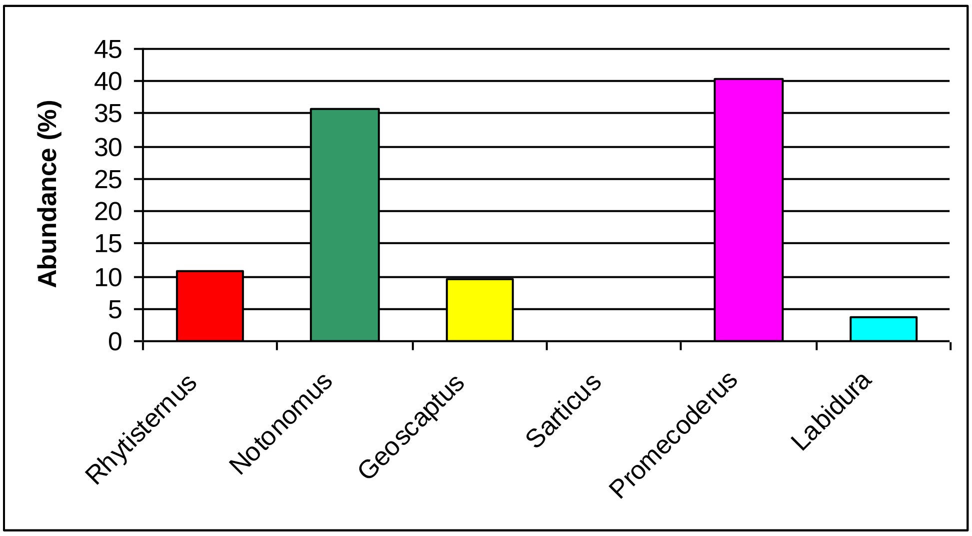
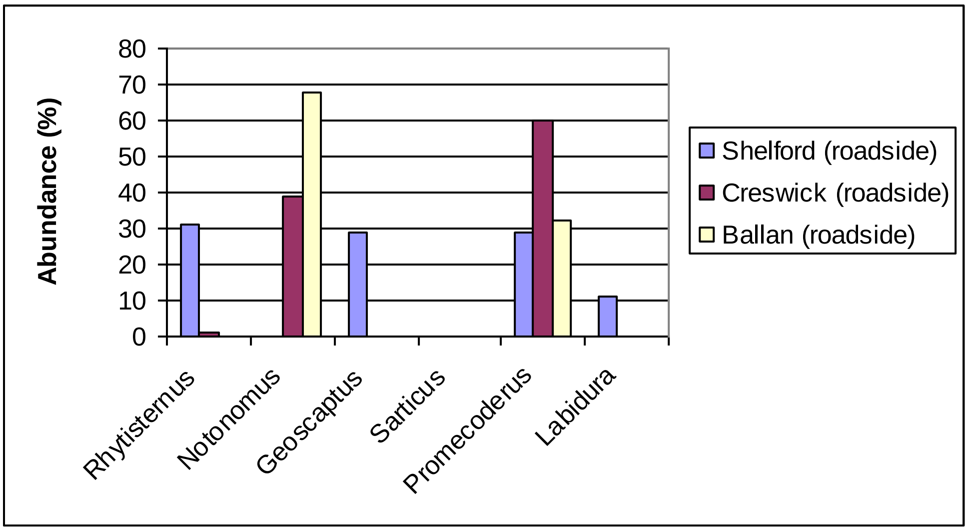
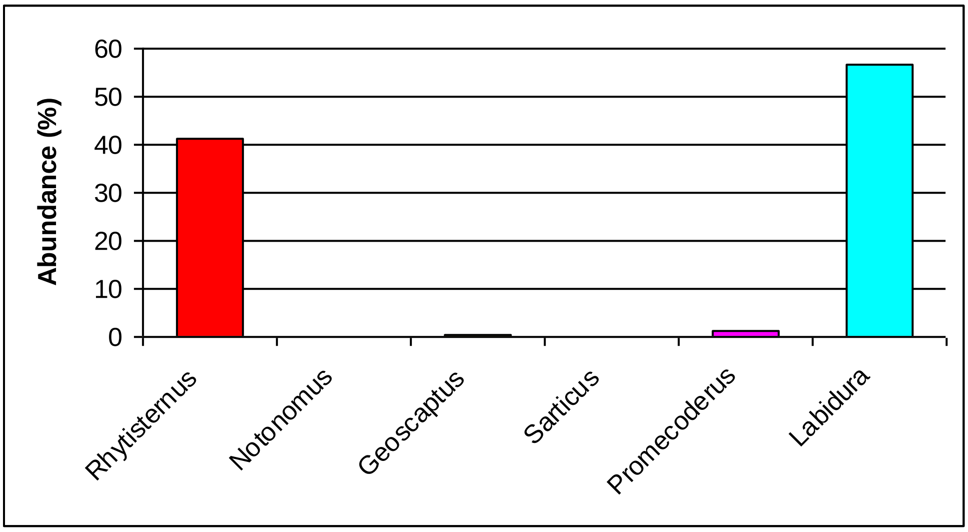


Figure 2: Relative abundance of beneficial species (roadside remnant native vegetation sites)



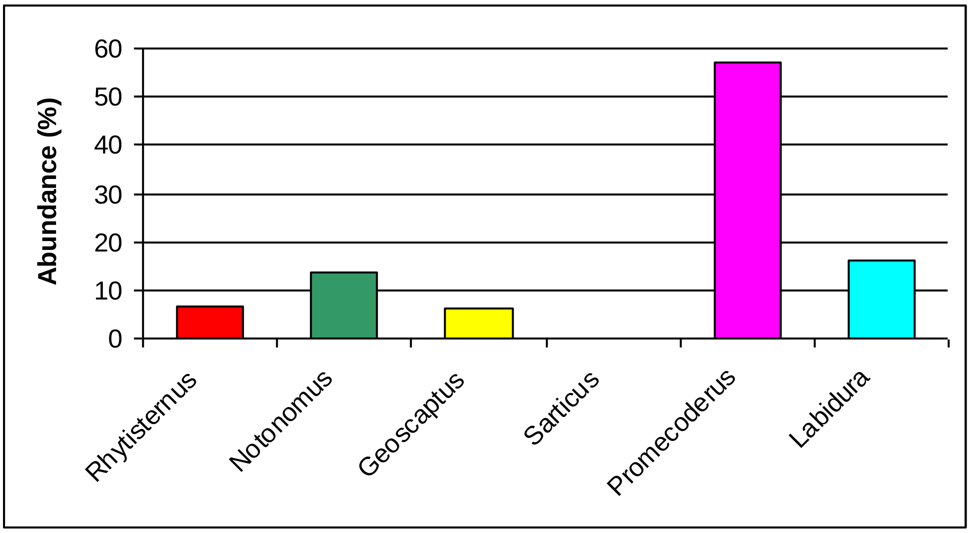
The cropping paddocks were dominated by one subspecies of carabid (*Rhytisternus)* and the beneficial native earwig *(Labidura truncate)* Figure 3. All sites had significant populations of these two species and they were the significant subspecies present.

Figure 3: Relative abundance of beneficial species (cropping sites)



In contrast, the improved pasture paddocks were dominated by a different subspecies of carabid beetle (*Promecoderus)*. This beetle was found at all seven sites and ranged between 17% and 92% of the total beneficial carabid and earwig populations. Similar to the cropping sites, the abundance of beneficial species in a pasture at *Emily Park* at Ballan was in the order of 10 times higher than a nearby native remnant grassland.

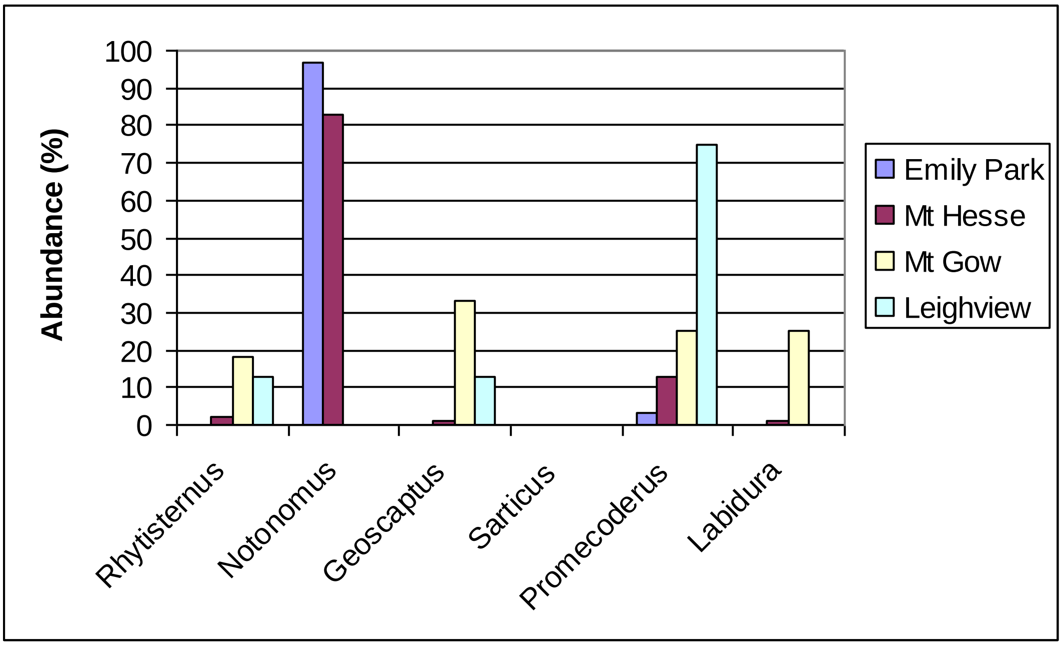
Figure 4: Relative abundance of beneficial species (pasture sites)



A fourth ecosystem type was included in later analysis. Farmers identified an unimproved grassland paddock (referred to as a 'native' paddock) for monitoring. The abundance of each species was measured and compared to the number and proportions found in the remnant native grassland.

Four of the five 'profiles' more closely matched the numbers and proportions found on improved perennial pastures (figure 5).

Figure 5: Relative abundance of beneficial species ('native' sites)



The fifth native grassland site at *Warrambeen* also contained carabid beetles P*romecoderus* and *Geoscaptus* but were in numbers 20 times lower that the average of the other native grassland sites.

A botanical analysis was conducted on four of the farmer selected 'native' paddocks. In three of the paddocks the grassland was dominated by exotic annual grasses and broadleaf plants (table 2).

Table 2: Proportion of species found in 'native' grassland paddocks

Property	Exotic species		Native species		Other observations
	Species	Prop'n (%)	Species	Prop'n (%)	
Mt Hesse	Soft Brome, Sub Clover, Silver grass.	90%	Common Wallaby-grass Slender Dock Kangaroo Grass.	3%	Rocky. Some litter (8%) Bare ground (1%)
Mt Gow	Phalaris, Soft Brome, Silver grass, Onion Grass.	65%	Kneed Spear-grass Velvet Wallaby-grass Basalt Tussock-grass *Poa labillardierei*	4%	Scattered rocks, Abundant litter (30%) Bare ground (23%)
Leighview	Phalaris, Soft Brome, Silver grass and Shivery grass.. Litter is abundant.	44%	Poison Lobelia *Juncus sp*	11%	Abundant litter (50%) Bare ground (4%)
Warrambeen	Onion Grass Yorkshire	13%	Wallaby-grass, Kangaroo Grass,	66%	Scattered rocks Litter (18%)

	Fog, Silver grass, Shivery grass		Pink Bindweed, Sheep's Burr, Bluebell, *Poa sp.* (Snow-grass), and Small Scurf-pea).		Bare ground (12%)

Trial observations
The number and type of carabid beetles and beneficial earwigs varies from the pasture, crop and remnant vegetation ecosystems.

In 37% of the monitored sites few or no species were recorded. Seasonality will influence the abundance of these species, as the larval stages are below ground and only the adult insects, moving on the soil surface were trapped. This may explain why the recorded populations in some sites were low. However expert opinion would suggest the previous paddock history is likely to have a greater influence on the current population than the seasonal variation. Carabid beetles have a long reproductive cycle so the loss of a population say through application of a broad spectrum insecticide can take many years to recover, especially if the breeding habitat is less than ideal. No analysis has been undertaken of the chemical application and farm practices applied to the study paddocks but are an obvious area for further investigation.

The large difference in beneficial insect numbers implies that achieving IPM may be achieved more quickly on some farms than others because of the existing resident population of beneficial species. The data also suggests that populations of beneficial species can survive in numbers believed to be sufficient to achieve the biological component of an IPM program.

When interpreting the data, it is important to examine both the relative proportions of each subspecies of carabid and the total number present, as it is possible to have dominance of one sub species but in numbers too low to achieve adequate pest control.

Collections during the study period have clearly shown that crops, pasture and remnant native vegetation contain different types and abundance of carabid beetle and native earwigs, enabling a 'population profile' to be established. Cropping paddocks tend to be dominated by the carabid *Rhytisternus* and the beneficial native earwig *(Labidura truncate).* In contrast the pasture paddocks were dominated by a different subspecies of carabid beetle (*Promecoderus)* with native earwigs and other carabid beetles in much lower proportions.

The reasons for the difference are speculative but may include insecticide use, herbicide use, crop rotation or simply a consequence of changing habitat structure. Altered habitat structure such as changing from tussocks to crop stubble or to heavily grazed pasture will modify habitat complexity. While this change to habitat structure is obvious, and may be the dominant factor, the additional reasons are likely to also contribute to the resulting invertebrate composition. The relative influence of these factors is yet to be determined.

Remnant native grasslands contained a greater diversity of carabid beetles but in numbers much lower than the cropping or pasture paddocks sampled. This finding has three important implications. The first is the number of beneficial species is unlikely to be in sufficient to provide direct biological control in adjacent paddocks. The beneficial species are simply outnumbered by the pests residing in the crop or pasture.

The second is at least one species of resident carabid beetle and earwig found in remnant native grassland is favoured by the environment created by cropping or pasture. These individual species are likely to move out of the native vegetation areas and breed successfully in the crop or pasture (assuming other actions are also taken to avoid killing them in the crop or pasture). This will eventually increase numbers in the crop or pasture to a level sufficient to provide some natural pest control.

Finally remnant native grasslands or even the establishment or enhancement of new areas of native grasslands is important to provide a reservoir of beneficial insects to repopulate crop and pasture areas.

An additional five ‘native’ paddocks were sampled to determine their beneficial species population profile. Four of the five profiles did not match the characteristics of the remnant native grasslands. The number of individual beneficial species in these four paddocks was much higher than a fifth ‘native’ paddock. These four paddocks were less diverse and better matched an improved pasture profile. This conclusion is supported by the composition of the vegetation in the ‘native’ paddocks, where these sites were dominated by exotic pasture species such as phalaris and weeds like soft brome, onion grass and silvergrass.

A paddock at *Warrambeen* was the only paddock of the five ‘native’ sites to exhibit a similar profile to remnant native grasses, but in much lower total numbers. This correlates to a higher proportion of native vegetation. In addition a large native species of weevil (as yet unidentified) was found only from remnant native grassland sites and from the *Warrambeen* native vegetation site.

It would be unwise to conclude a ‘native’ pasture will necessarily have the same characteristics of remnant native vegetation and therefore will automatically be a good source of native biodiversity, especially the key beneficial species discussed here. It is also unclear if the difference in beneficial insect population between the *Warrambeen* site and others is solely due to vegetation diversity and structure or other factors have contributed to the shift.

The findings also suggest that if ‘native’ sites lose their diversity (through whatever reason) and become dominated by exotic species such as phalaris, soft brome and silvergrass they will lose their carabid beetle diversity but increase in beetle number. They will also support invertebrate populations more like an improved pasture.