FINAL REPORT

RITA Project No: RT 04/17-4

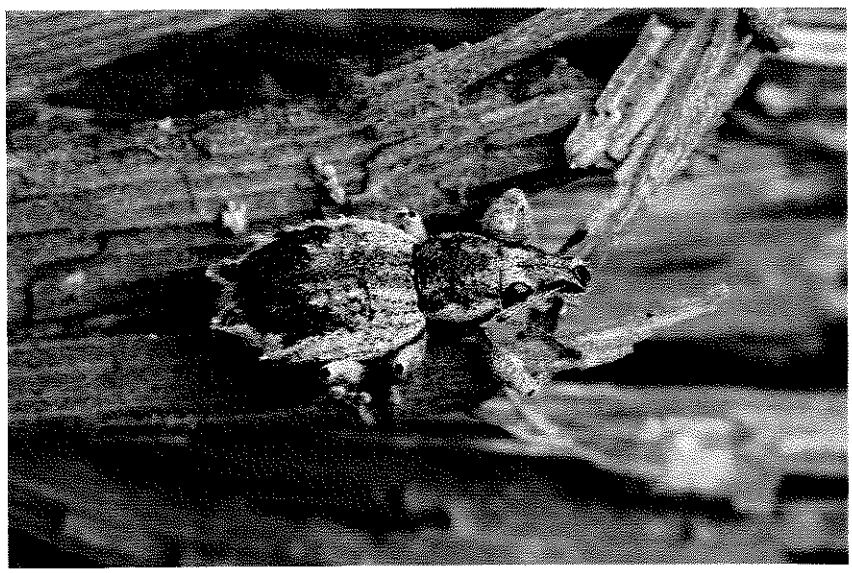
Development of control strategies for the native weevil, *Ecrizothis boviei*, attacking grapevines in the Yarra Valley

---

Prepared by: Peter Cole
IPM Technologies Pty Ltd
PO Box 560
Hurstbridge Vic 3099

For: Yarra Valley Winegrower's Association Inc.
PO Box 1242
Healesville Vic 3777

May 2006



Contents

Executive Summary..... 2

Introduction..... 3

Materials and Methods..... 4
- Vineyard locations..... 4
- Seasonal monitoring of weevil abundance..... 4
- Biology and life history..... 5
- Pesticide Efficacy..... 6
- Effect of weevils on crop yield..... 6

Results 6
- Seasonal monitoring of weevil abundance..... 6
- Biology and life history..... 8
- Pesticide Efficacy..... 10
- Effect of weevils on crop yield..... 10

Discussion..... 12

References..... 14

Executive Summary

This project describes the pest status of a native weevil, *Ecrizothis boviei* Lea, which in recent years has infested Chardonnay grapevines at two vineyards in the Yarra Valley, Victoria. To our knowledge there has been only one previously documented specimen of *Ecrizothis boviei* from grapevines in Victoria (specimen held at DPI, Knoxfield) and this report appears to be the first publication of *E. boviei* as a pest of grapevines.

The life cycle of *E. boviei* was investigated and we found that emergence of adult weevils coincides with budburst of Chardonnay grapevines during September. Weevils feed on primary buds and developing shoots and will continue to damage secondary buds if not controlled. Egg laying occurs in early November and adults can remain on the grapevines until at least January.

Selective insecticides which are compatible with integrated pest management were tested for efficacy against *E. boviei* in laboratory trials. Indoxacarb (Avatar®) produced 100% mortality of adult weevils in the laboratory. Field applications of indoxacarb to infested grapevines were highly effective in reducing the population sizes of the adult weevils. It appears that timing of the applications is critical in preventing economic loss.

The immature stages (larvae and pupae) of *E. boviei* were not found in or around the vineyards despite extensive soil searches. The location of developing immature stages needs to be ascertained so that control strategies which target these stages can be investigated.

The information in this project on the biology and life-history of *Ecrizothis boviei* will assist in preventing the spread of this weevil. Grape growers in the Yarra Valley will have control strategies for the weevil which are compatible with integrated pest management.

Introduction

Several species of weevils have been well documented as pests of grapevines in Australia (Nicholas, *et al* 1994). These species include *Otiorhynchus sulcatus* (black vine weevil), *Phlyctinus callosus* (garden weevil), *Naupactus leucoloma* (whitefringed weevil) and *Asynonychus cervinus* (Fuller's rose weevil). This project documents a native species of weevil, *Ecrizothis boviei*, which has become a localised pest of grapevines in the Yarra Valley, Victoria. There do not appear to be any previous publications of this species being a pest of grapevines in Australia.

Ecrizothis boviei Lea (Coleoptera: Curculionidae) belongs to the Adelognatha group of native weevils. The larvae of this group are root feeders, living more or less freely in the soil among the roots of woody plants or grasses. Adults are flightless. *E. boviei* has been recorded feeding on apple (*Malus*) and one previous specimen is known from grapevines. A related species, *E. inaequalis* also feeds on apple as well as on cherry and gooseberry (R. Oberprieler, CSIRO Entomology, pers. comm.). There are no other records known to us of *E. boviei* in Australia.

In recent years *E. boviei* has caused significant damage to grapevines at two vineyards in the Yarra Valley, Victoria. Damage to Chardonnay grapevines from the feeding of weevils increased in severity from when they were first noticed in 2002. Adult weevils appear on grapevines in September each year and feed on buds and developing shoots. The areas of infestation at both vineyards increased in number and area during each season after 2002/03. It is estimated that a total of 6.5 Ha of grapevines were infested during 2005/06. Infestations are primarily on Chardonnay, and to a lesser extent on Pinot Noir and Pinot Meunier. The vineyards are approximately 5km apart and are largely surrounded by native forest vegetation.

Integrated pest management principles are employed for pest control at both vineyards. This broadly involves monitoring for pests and beneficial species during the growing season and employing biological and cultural control options where possible. Selective insecticides which target specific pest species are chosen over broad-spectrum insecticides.

During the 2004/05 growing season attempts were made to control the growing *E. boviei* populations with carbaryl insecticide. Although there appeared to be moderate reductions in the size of the weevil populations, there was concern over the effectiveness of the treatments and the potential negative impact on beneficial insects and mites in the vineyard.

The purpose of this project is to gain biological information about *Ecrizothis boviei* and to examine potential control strategies so that the spread of this pest can be halted within the affected vineyards. The potential for *E. boviei* to broaden its range to other vineyards within the Yarra Valley can also be minimised.



Figure 1. Chardonnay grapevines showing a patch in the middle ground where buds and young shoots have been almost completely stripped by feeding from *Ecrizothis boviei.*

Materials and Methods

Vineyard locations
Hoddles Creek Vineyard, Prices Rd, Hoddles Creek, Vic, 3139
This vineyard is referred to as 'Prices Rd' in this report.

Hoddles Creek Vineyard, Beenak Rd, Hoddles Creek, Vic, 3139
This vineyard is referred to as 'Beenak' in this report.

Contact: Craig Callec, Vineyards Manager, Ph. 03 5967 4353

Seasonal monitoring of weevil abundance
Both vineyards were monitored for adult weevils at fortnightly intervals from 20 May to 16 September 2005 and at weekly intervals from 16 September to 15 December 2005. From January to May 2006 monitoring was conducted monthly. Searches for juvenile weevils were conducted about once per month throughout the life of the project.

Adult weevils were monitored by direct searches on Chardonnay grapevines and by placing corrugated cardboard bands around the trunks of vines to capture migrating weevils. Direct searches were conducted on 30 randomly selected grapevines by examining under the loose bark of the trunk and major branches. The number of weevils per 30 grapevines was recorded.

From May to October 2005, corrugated cardboard bands were secured around the trunks of Chardonnay grapevines at each vineyard. Bands were placed around twenty randomly selected grapevines each fortnight and were left in place for 14 days. They were then removed and examined for the presence of weevils sheltering inside the cardboard bands.

Soil searches for juvenile weevils (larvae and pupae) were conducted in the root zone of grasses and weeds in the inter-row spaces and around the root structures of the grapevines. The inter-row spaces were sampled by digging ten holes (20x20x20cm) in randomly selected inter-row locations and then breaking up and sifting through the soil. The soil around grapevines was searched by digging to a depth of 20cm around part of each of five plants. Soil searches in bordering native forest were also undertaken. The branches and canes of grapevines were also examined periodically for immature stages.

Applications of insecticide to target the weevils were made on occasions throughout the growing season to sections of the vineyard where *E. boviei* was detected (Table 1). Applications were made with a high water volume of 1000 L/Ha.

Table 1. Summary of insecticide applications to infested blocks at Prices Rd and Beenak vineyards.

Date	Vineyard	Treatment		Rate
		Product	Active ingr.	(product)
6 Sep 05	Prices Rd	Bugmaster Flowable	carbaryl	200 ml/100L
19 Sep 05	Beenak	Bugmaster Flowable	carbaryl	200 ml/100L
27 Sep 05	Prices Rd	Avatar	indoxacarb	17 g/100L
4 Oct 05	Beenak	Avatar	indoxacarb	17 g/100L
13 Oct 05	Prices Rd	Avatar	indoxacarb	17 g/100L

Biology and life history

A colony of adult *E. boviei* collected from the vineyards was maintained at our laboratory at St Andrews, approximately 40km from the vineyards. The colony was not exposed to artificial heating so that weevils encountered climatic conditions that were somewhat similar to conditions at the vineyards. Batches of 30 *E. boviei* were kept in plastic crisper boxes (27x20x8cm) with Chardonnay grapevine leaves as a food source, saturated cotton wool for moisture and sections of grapevine bark for shelter.

Female weevils collected from the field were dissected on four occasions during September and October 2005 to determine the maturity of their eggs and whether or not they had commenced egg-lay. The wing case and dorsal surface of the abdomen was removed under a binocular microscope to expose the oviducts. The size of developing eggs was measured to determine if they were mature or immature, and the presence or absence of corpora lutea (brown colouration adjacent to the ovipositor) indicated if egg laying had occurred.

No-choice feeding trials were performed to determine if different varieties of grapevine leaves were acceptable food sources for adult *E. boviei*. Five repetitions of single weevils

were offered Chardonnay, Cabernet Sauvignon, Pinot Meunier or Shiraz leaves over a seven day period. The amount of leaf tissue consumed was estimated.

The longevity of weevils in the laboratory colony was recorded. Data from both the laboratory colony and field collections were combined to propose a seasonal life-cycle for *E. boviei*.

Pesticide efficacy
Four insecticides were tested in laboratory bioassays to determine their efficacy against *E. boviei*. Indoxacarb (Avatar®), emamectin (Proclaim®) and spinosad (Success®) were assessed because they are considered to be IPM-compatible insecticides due to their reasonably narrow selectivities, and carbaryl (Bugmaster Flowable®) was assessed because it produced some reduction in the weevil population when sprayed in the vineyards during 2004/05.

Twenty adult weevils per treatment were sprayed to the point of saturation with a hand-held pressurised atomiser from a distance of 30cm. They were placed into round plastic containers (500mL capacity) with Chardonnay leaves and saturated cotton wool. Escape was prevented by a ventilated lid. The weevils were incubated at 24°C and 14L:10D photoperiod for 48 hours. Mortality was then assessed. Mortality was defined as being unable to walk or move freely when prodded with a fine paint brush.

Effect of weevils on crop yield
The number of grape bunches per panel length of grapevine row was counted in infested and non-infested areas of Chardonnay blocks during December 2005 to determine if *E. boviei* caused significant yield loss.

Bunches of grapes in ten randomly selected panels of infested and non-infested areas were counted. The panels selected in the non-infested areas were from different sections of the blocks surrounding the infested area. The data was transformed to "number of bunches per metre of row" and statistically analysed using Analyse-It Statistical Software Version 2.1.

Results

Seasonal monitoring of weevil abundance
Direct searches for adult weevils under the bark were effective methods of monitoring relative abundance. Weevils were found by this method from early October 2005 until January 2006 (in an unsprayed area). The cardboard bands were not effective at trapping weevils and none were captured by this method.

The number of adult weevils in the infested areas of Chardonnay reached high numbers prior to employing control strategies. At Prices Rd numbers peaked at about 70 weevils per 30 vines and at Beenak they reached about 35 weevils per 30 vines (Fig. 2). These

were relative counts done by searching under the bark on the trunk and major branches. Absolute numbers of weevils were likely to be higher.

During the season it was necessary for control strategies to be implemented. Carbaryl (Bugmaster) was applied at both vineyards during September 2005 (Fig. 2). The application did not stop an increase in weevil numbers at Prices Rd vineyard and it had a moderate effect in reducing the number of weevils at Beenak vineyard by about half.

Indoxacarb was applied once at Beenak in early October and twice at Prices Rd during September and October following successful trials with this insecticide in laboratory bioassays (see below). The field applications greatly reduced the number of weevils and no further specimens were found on the grapevines after late October. In comparison, adult weevils continued to be found in a small unsprayed area of six rows of Chardonnay until January 2006.

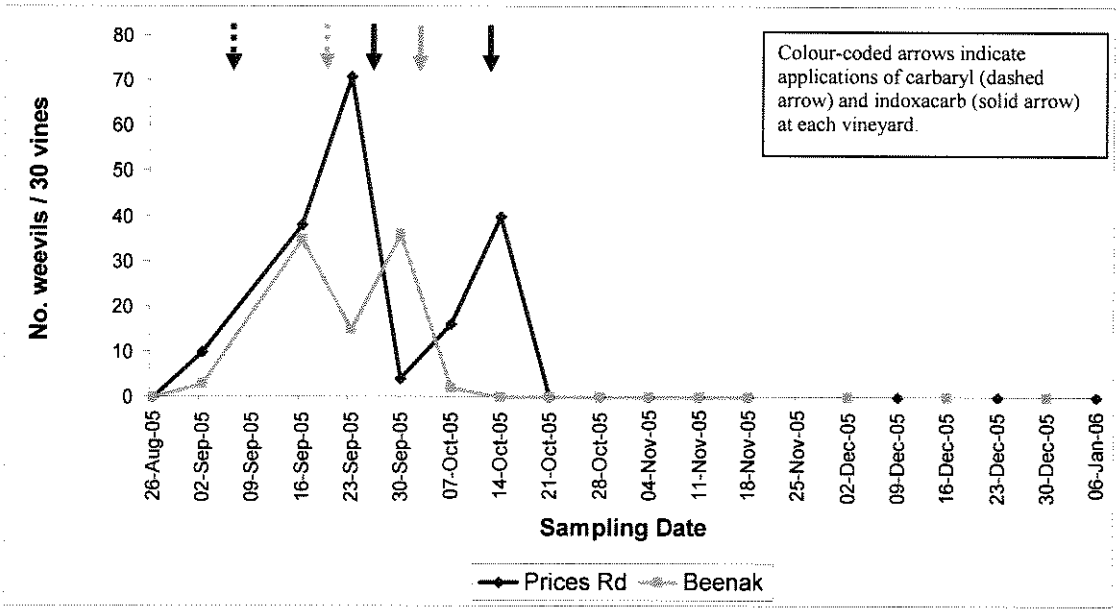


Figure 2. Abundance of *Ecrizothis boviei* on Chardonnay grapevines at two vineyards and the effect of insecticide applications on abundance.

The secondary peaks in weevil abundance following the initial insecticide applications at both vineyards indicate that adult weevils were still emerging from pupae until early to mid-October.

No larvae or pupae of *E. boviei* were found despite extensive soil searches in the inter-row spaces, amongst the roots of grapevines and in bordering native forest. No specimens were found in the branches or canes of grapevines.

Biology and life history

The larvae of *E. boviei* are likely to be root feeders and live freely in the soil among the roots of plants such as grasses or shrubs (R. Oberprieler, CSIRO Entomology, pers comm.). Adult weevils are 10-13mm in length and 2.5-3.0mm body width (males) and 3.0-4.5mm body width (females). Body colouration closely resembles the underside of grapevine bark where they shelter during daylight (Fig. 3). They are primarily nocturnal feeders.



Figure 3. *Ecrizothis boviei* on underside of grapevine bark.

The emergence of adults occurred during the entire month of September and into early October. Captured adults laid eggs in our colony between 2 – 14 November, and eggs hatched within three days. Dissections of field-collected females showed that they carried immature eggs during September and early October (Table 2). From mid-October, females with mature eggs were present and the proportion of females which had laid eggs increased during the latter half of October.

Adult weevils remained alive in our colony until mid-January, and specimens were found in an untreated section of the Prices Rd vineyard until January, indicating that adults appear to survive for approximately four months over spring and early summer.

Table 2. Maturity of eggs in female *E. boviei* collected from Prices Rd Vineyard during 2005.

Collection date	Immature eggs No. females	Mature eggs No. females	Eggs laid No. females
19 Sep	6	0	0
3 Oct	8	0	0
12 Oct	5	3	1
27 Oct	1	4	3

Feeding trials in the laboratory showed that adult *E. boviei* will feed on Chardonnay, Cabernet Sauvignon, Pinot Meunier or Shiraz leaves. There was no difference in the amount of leaf tissue consumed of the different varieties over seven days.

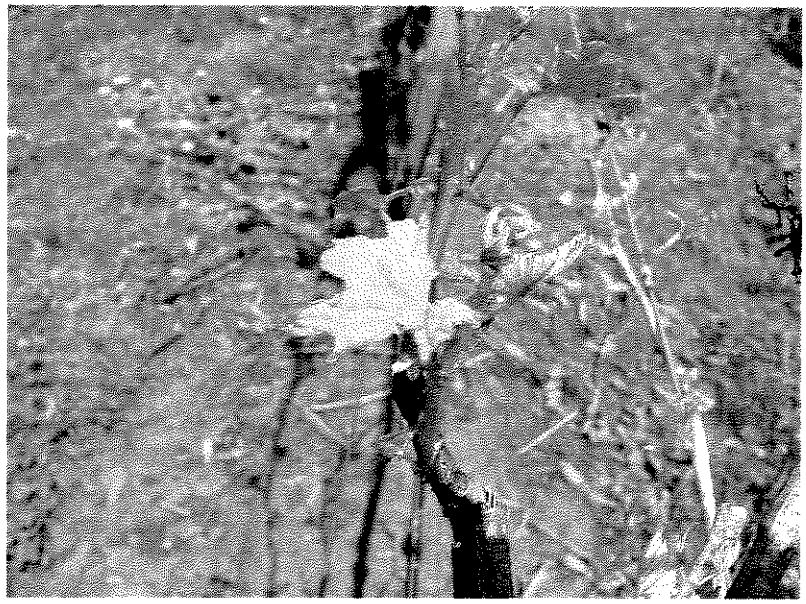


Figure 4. Damage to Chardonnay shoots by feeding from *E. boviei.*

From data collected in the field and the laboratory colony, a life-cycle for *Ecrizothis boviei* in the Yarra Valley is proposed (Fig. 5). Adult emergence and their presence on the grapevines were recorded and the timing of egg-laying established, but it remains unclear as to the location of juveniles and timing of pupation.

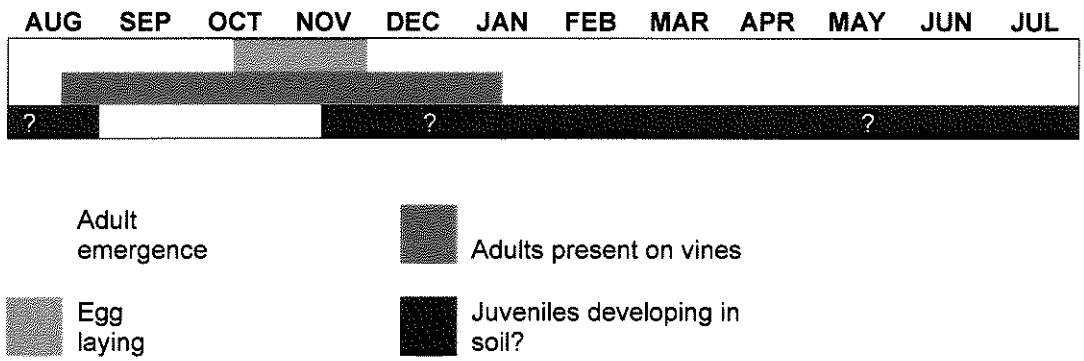


Figure 5. Proposed life-cycle of *Ecrizothis boviei* at Hoddles Creek, Victoria.

Pesticide efficacy

The laboratory bioassays showed that carbaryl and indoxacarb have activity against adult *E. boviei* whereas emamectin and spinosad have no direct toxicity (Table 3). Indoxacarb showed the greatest potential for controlling *E. boviei* in vineyards. Weevils sprayed with indoxacarb did not feed after treatment which indicates that death is by contact rather than by ingestion. Carbaryl was moderately toxic.

Table 3. Effect of insecticides on mortality of adult *Ecrizothis boviei.*

Insecticide	**Rate equiv. (g or ml/100L)**	**Mortality of adult *E. boviei* (%)**
control (water)	-	0
carbaryl	200	65
indoxacarb	17	100
indoxacarb	34	100
emamectin	15	0
spinosad	40	0

Effect of weevils on crop yield

The number of grape bunches per metre of vine row in infested and non-infested areas at Prices Rd were significantly different where indoxacarb was not applied (Block 1) and were not different where indoxacarb was applied (Block 8) (Table 4). That is, when insecticide was not applied to control *E. boviei*, the weevils caused a significant loss of grape bunches by feeding on the developing shoots in spring.

Table 4. Number of grape bunches in infested and non-infested areas of Chardonnay blocks at Prices Rd Vineyard.

Block No.	Area sampled	No. applications indoxacarb 2005/06	Mean no. grape bunches / m row	± 95% CI
1	infested	0	12.8	11.2 - 14.4
1	non-infested	0	19.4	17.0 - 21.8
8	infested	2	16.1	14.9 - 17.3
8	non-infested	0	13.8	12.5 - 15.1

At Beenak, there were significantly fewer grape bunches in the infested area compared to two non-infested areas (Table 5), despite indoxacarb being applied on 4 October 2005. The infested area contained only about one-third the number of bunches as the non-infested areas. The quality of the remaining bunches in the infested area was very poor at the time of harvest (C. Callec, Vineyard Manager, pers. comm.). This resulted in no grapes being harvested from the infested area of Chardonnay at Beenak in 2006.

Table 5. Number of grape bunches in infested and non-infested areas of Chardonnay blocks at Beenak Vineyard.

Block No.	Area sampled	No. applications indoxacarb 2005/06	Mean no. grape bunches / m row	± 95% CI
23	infested	1	7.3	5.0 - 9.6
23	non-infested (north)	0	24.0	21.7 - 26.3
23	non-infested (west)	0	18.1	16.0 - 20.2

Discussion

This project is the first report of *Ecrizothis boviei* being an important pest of grapevines. Although its occurrence has been limited to two vineyards in the Yarra Valley, the destructive nature of feeding by the adult weevils means that it has the potential to cause high yield loss in vineyards where it establishes.

E. boviei adult weevils cannot fly but climb up trunks and along branches to reach green foliage. Movement to new areas is limited by the distances weevils can walk but could be aided by transport on farm machinery or on farm workers. Most weevils shelter during daylight under bark, but some remain on green shoots where they are liable to being dislodged. Control of adult weevils in spring before the growth of canes brings the grapevines into contact with passing machinery such as tractors and sprayers could help to prevent dispersal of the weevils.

The major infestations at both vineyards were on Chardonnay grapevines and there were minor infestations on Pinot Noir and Pinot Meunier. Chardonnay is probably the favoured host because its early budburst in mid-September coincides with the appearance of adult weevils. Feeding damage to buds was observed at the first sign of green tissue emerging. The laboratory feeding trials showed that other varieties of grapevines are acceptable food sources; hence the preference for Chardonnay in the field is likely to be due to the availability of green plant tissue when adults emerge in September.

E. boviei is a native weevil but the distributions of infestation were not all adjacent to the surrounding eucalypt forest, and infestations were not necessarily heaviest on the edges of grapevine blocks. This suggests that, although the weevil may have initially come from surrounding forest, the appearance of adult weevils is not due to annual migration from outside the vineyards, but rather that they are established in the vineyard blocks. However, given the high number of adult weevils found, it is unclear why juvenile stages could not be located in soil within the vineyards. The location of developing larvae and pupae and the timing of pupation needs to be determined so that control strategies for these stages can be investigated.

The laboratory bioassays showed that indoxacarb was highly effective against adult weevils. The weevils stopped feeding after being treated and were all killed within 48 hours of treatment. The mode of action of indoxacarb is therefore by contact rather than by ingestion. IPM Technologies Pty Ltd has previously determined through field trials that indoxacarb has activity against immature stages of vegetable weevil, *Listroderes difficilis* (unpublished data).

Our previous studies (Cole, 2004) showed that indoxacarb is a useful insecticide for crops grown under integrated pest management because it displays some insecticidal selectivity. Laboratory bioassays indicated that it is safe towards the predatory mite, *Galendromus occidentalis,* and the predatory brown lacewing, *Micromus tasmaniae*, but it is moderately toxic towards the green lacewing, *Mallada signatus*.

In this study, eggs of *M. signatus* were counted during November in blocks treated with indoxacarb and in untreated blocks (data not shown). No difference in the number of eggs was detected between blocks. The indoxacarb was applied prior to the appearance of *M. signatus* and therefore had no effect on populations of this beneficial species.

Carbaryl was moderately toxic to *E. boviei* in the laboratory bioassays and was not particularly effective in the early-season field applications. Also, carbaryl is toxic to a wide range of beneficial insects, and is therefore not considered to be useful for controlling this weevil, particularly if integrated pest management is practised.

The timing of application of indoxacarb appears to be critical and there may be a necessity for two applications per season. Firstly, at Prices Rd vineyard the applications on 27 September and 13 October killed adult weevils and prevented significant yield loss, as indicated by bunch counts later in the season. At Beenak vineyard the single application of indoxacarb on 4 October appears to have been too late to prevent major damage and significant yield loss, despite this single application killing off the adult weevil population. This suggests that indoxacarb should be applied before the end of September. Secondly, applications need to be made before females begin to lay eggs so that the next generation cannot be established. The dissections of females from the field and observation of the laboratory colony showed that eggs are laid from mid-October until mid-November. It is therefore essential for weevils to be controlled before mid-October.

The actual effect of the applications of indoxacarb on the population size of the next generation should be investigated during spring 2006. This will help to determine whether insecticide applications are useful for long-term (season-to-season) control. Horne *et al* (1997) showed that juvenile stages of garden weevils in vineyards can be controlled by rotary hoeing between rows when the weevils are pupating. IPM Technologies Pty Ltd has since found that this method reduces the size of the weevil population for several seasons, thus giving long-term control. The location of immature *E. boviei* would need to be established before this type of control strategy could be considered.

This project has provided information on the life-history of this new pest species in the Yarra Valley. Understanding its biology is vital for enabling control methods to be established which are both effective and compatible with pest management for other species such as lightbrown apple moth and mites.

Specimens of *Ecrizothis boviei* have been lodged with the Victorian Agricultural Insect and Arachnid Collection, Department of Primary Industries, (621 Burwood Hwy, Knoxfield, Vic, 3180).

References

Cole, P.G. (2004). *Testing pesticide sprays for use with biological control and integrated pest management*. Report to Dried Fruits Trust Inc. PO Box 5042, Mildura, Vic, 3502.

Horne, P.A., C.L. Edward & J. Curtis (1997). Control of garden weevil without insecticides. *The Australian Grapegrower and Winemaker*. Annual technical Issue 1997. pp109-110.

Nicholas, P., P. Magarey & M. Watchel (eds) (1994). *Diseases and Pests – Grape Production Series Number 1*. Winetitles, Adelaide.