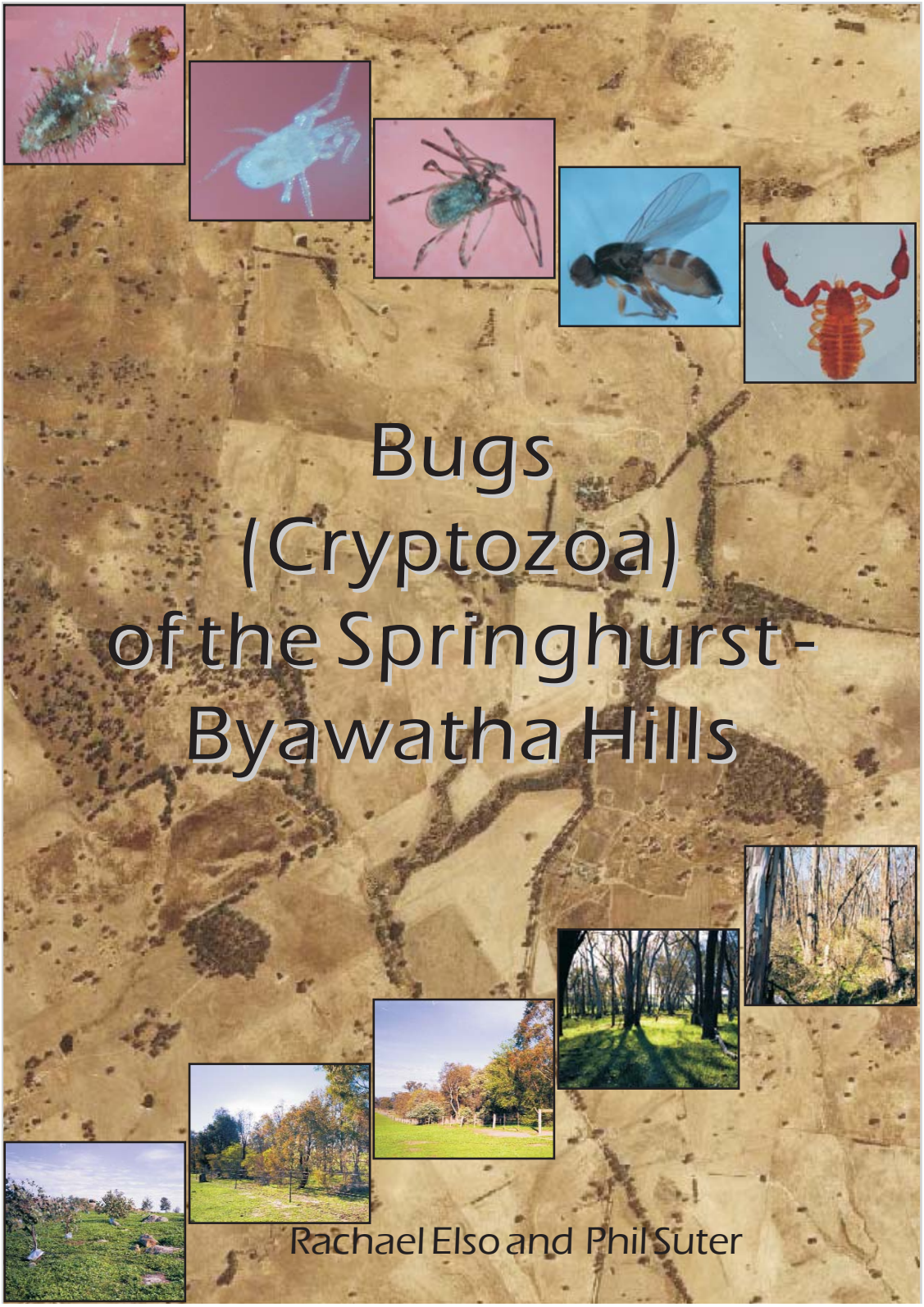

Bugs (Cryptozoa) of the Springhurst - Byawatha Hills

Rachael Elso and Phil Suter

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Compiled from a thesis submitted in partial fulfilment of the requirements for the Degree of Bachelor of Science in Environmental Management and Ecology with Honours 2003.
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Acknowledgements

I would like to thank the following people for all their support:
My supervisor, Phil Suter.
La Trobe University and the staff and students in the Department of Environmental Management and Ecology.
The Springhurst and Byawatha Hills Landcare group
Sue Leavold, Sandy and Sue Campbell, Lauchlan and Penny Campbell, Matt and Mandy Allen and Lindsay Humphry.
Mary Titcumb from Deptartment of Primary Industries for preparing this document for publication.
Natural Heritage Trust

Contents

Introduction

Terrestrial Biodiversity Survey

Springhurst and Byawatha Hills Landcare Group evolved in 1988 from one of the earliest Farm Tree groups formed in the state of Victoria.

Land types in the district vary from fertile riverine plain to undulating hills and rocky outcrops.

Land clearing throughout the region has been extensive. Carried out initially to comply with terms and conditions of Government leasehold prior to freehold being granted and continuing on, during the early twentieth century, to fuel the powerhouse at the Eldorado mine and goldfields.

As late as the nineteen sixties clearing was continuing on some properties, whilst on others, some farsighted landholders had begun collecting seed from trees growing locally, and were starting to implement revegetation work.

With some of these early revegetation sites approaching thirty years of age, farmers were beginning to ask themselves questions about the ecological benefits of all this replanting.

The advantages of shade and shelter for protection for livestock were quite evident, but what were the benefits for wildlife?

One option was to carry out bird surveys across a number of properties, but an alternative suggestion, to investigate macroinvertebrate populations in revegetation sites, awakened an enthusiastic response.

What Would Landholders Like to Know?

The concept of the project became to find out more about terrestrial BUGS (cryptozoa) in re-vegetated sites. Was the re-vegetation work producing the results we expected, or should it be more productive? Invertebrates are an important source of bird food, they break down plant material and create organic matter, and some predate on other invertebrates that

may destroy crops, pastures etc. Questions that the research will be used to answer include:-

· What invertebrates do live in and on the soil surface and in the ground litter of revegetation sites?

· Are the invertebrate populations in newly planted sites of two to three years of age the same as those found in older, more established sites?

· Are older sites providing habitat for a wider range of invertebrates?

· Does exclusion of stock impact on the abundance and diversity of invertebrates? And how long does it take for the re-establishment of communities post exclusion?

· If we look at an undisturbed site in the Barrambogie State Forest which has a far greater complexity of native plants including grasses, sedges, herbs, heaths, lilies and orchids, do the invertebrate populations found there vary significantly from fenced remnants?

How Can We Find Out?

Four members of the group volunteered revegetated sites to Rachael Elso to complete a research project monitoring invertebrate succession within the Landcare boundaries. Sites monitored contained vegetation that was either two to three years old, around ten years, twenty years and over, or remnant. Each site had stock excluded for at least three to four years. A site in the Barrambogie State Forest was also sampled to give an indication of an "undisturbed" site.

By early March 2003, Rachael had been busy placing holes in the ground for test tubes to create pitfall traps, and had put in sixty test tubes.

During the scientific sampling carried out at regular intervals during the project period, tops were taken off the test tubes, and they remained open for a week in each sampling period to trap any invertebrates that entered. Test tubes were collected at the end of the sampling week, in addition to leaf litter sampling from all the sites which was used as an additional

monitoring method.
Little scientific research has been done in this area, so the Landcare Group by making sites available for invertebrate collection, together with Rachael, for whom the project underpins an Honours Thesis, and Dr Phil Suter, her supervisor, have made a valuable contribution to our knowledge and understanding.

Susan Leavold Landcare Coordinator

Study Description

Revegetated agricultural ecosystems at different ages were studied in Byawatha, Victoria (see Figure 1) to determine how abundance, diversity and community structure of cryptozoa (soil and litter invertebrates) varied in relation to restoration age. Three locations were chosen that contained vegetation in each of four alternate age groups: remnant vegetation, and vegetation aged 20-30, 10-11 and 2-3 years of age.

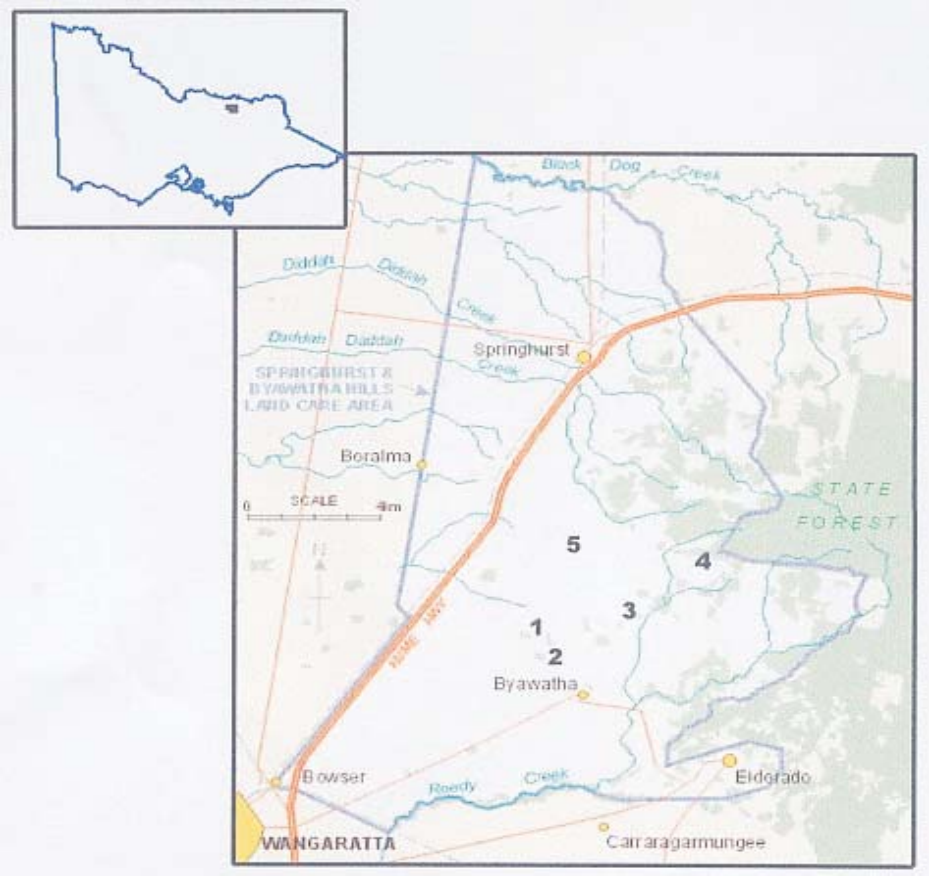

Figure 1 Map of Springhurst and Byawatha Hills Landcare area in Northeast Victoria. Numbers indicate properties (Page 11 and 12) that contained study sites for the assessment of cryptozoa communities along a gradient of time in 2003.

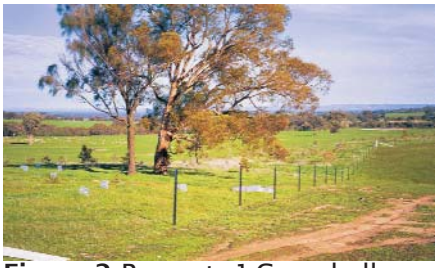

Figure 2 Property 1 Campbell revegetation site 1-2 years old.

Figure 3 Property 1 Campbell revegetation site 20 years old.

Figure 4 Property 2 Campbell remnant vegetation site.

Figure 5 Property 3 Allen revegetation site 1-2 years old.

Figure 6 Property 3 Allen revegetation site 10-11 years old.

Figure 7 Property 4 Barrambogie State Forest remnant vegetation.

Figure 8 Property 5 Humphry revegetation site 10-15 years old.

Figure 9 Property 5 Humphry remnant vegetation site.

Site Descriptions

Property 1 - This property owned by Sue and Sandy Campbell was located near Byawatha at 146°28'49"E, 36°15'50"S. Prior to restoration the study areas were used primarily for grazing at a rate of 8 DSE/Ha. This property contained four sites, which were exposed to different management techniques (see Figures 2 and 3).

Property 2 - This property owned by Lauchlan and Penny Campbell was located near Byawatha at 146°28'28"E, 36°16'17"S. Surrounding land practice included light winter grazing and a vineyard that was approximately 50 acres. The property contained one remnant study site (see Figure 4).

Property 3 - This property owned by Matthew and Mandy Allen was located in Byawatha at 146°30'14"E, 36°16'23"S. Prior to restoration the study areas were used for grazing at a rate of 2 DSE/Ha. The property contained two different study sites, which were exposed to different management techniques (see Figure 5 and 6).

Property 4 - The Barrambogie State Forest was located in Byawatha at 146°30'54"E, 36°14'43"S. The State Forest was bordered by South Triangle and Nankervis roads. This property contained one remnant study site (see Figure 7).

Property 5 - This property owned by the Humphry family was located in Byawatha at 146°27'51"E, 36°13'43"S. Prior to restoration the study areas were used primarily for grazing at a rate of 8 DSE/Ha except for the remnant bush that was grazed at 1-2 DSE/Ha. The property contained four study sites, which were exposed to different management techniques (see Figures 8 and9).

Methods of Obtaining Cryptozoa

Five pitfall traps and five litter samples (see Figure 10)were taken from each site at three eight-week intervals between March and July 2003. Litter samples were then placed in a tulgren funnel (Figure 10b) to separate cryptozoa for sorting and identification. Cryptozoa were sorted at least to order and then morphospecies. During sampling a number of environmental parameters were also assessed, including: air temperature, soil temperature, soil moisture, litter moisture, vegetation structure and distance to nearest edge. These parameters were assessed to evaluate whether alterations in cryptozoan abundance and diversity could have been influenced by something other than vegetation age.

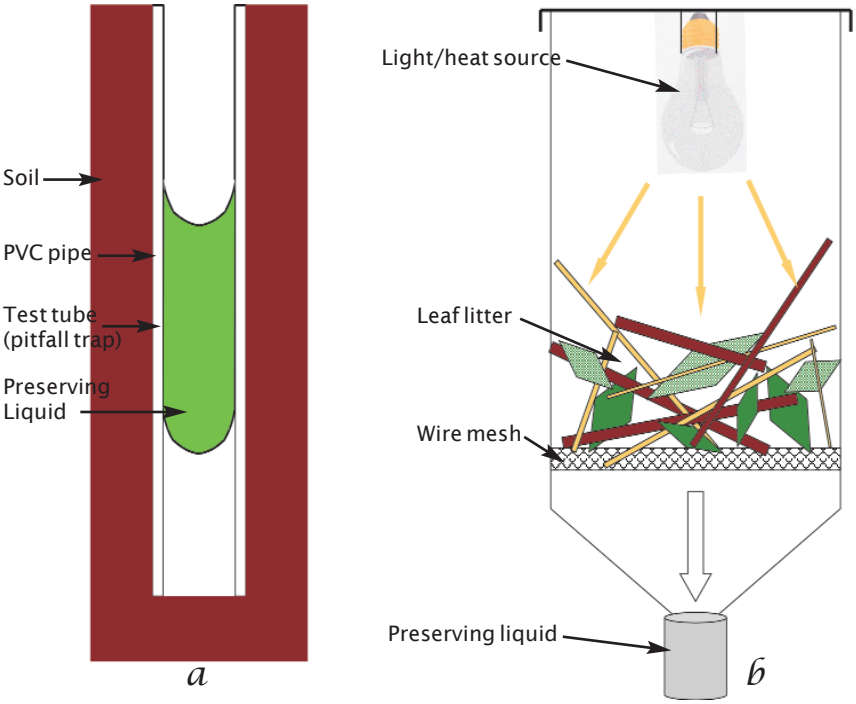

Figure 10*a* Pitfall Trap; *b* Tulgran Funnel. For detailed descriptions of pitfall traps and tulgran funnels, see glossary.

Common Cryptozoa

362 morphospecies and approximately 38535 invertebrates were collected over three samples. There were seven main invertebrate orders that indicated a difference between vegetation age and sample time; these were spiders, mites, millipedes, centipedes, springtails, beetles and ants.

Araneae (Spiders) (Figure 11 a-g)

Total abundance: 180
Total diversity: 62
Average size: Specimens collected ranged from approximately 1-2mm up to 10cm.
Spiders are mostly distinguished from insects by having eight legs and only two body sections. They do not have chewing mouth-parts, but instead kill their prey with poison, dissolve the edible parts with enzymes and, finally, ingest the liquid.
Habitat: Spiders may be found in leaf litter, under logs or rocks and are commonly found living in man-made shelters.
Primary role: Spiders are typically predators and feed on small invertebrates, lower in the food chain.
Ecology: Spiders assist in the regulation of communities by feeding on more numerous prey.

Acarina (Mites) (Figure 12 a-d)

Total abundance: 11348
Total diversity: 42
Average size: Specimens collected were all <1-2mm in size.
Habitat: Mites are common in soil and leaf litter environments, they may also be found in the bark of trees, plant leaves and stems.
Primary role:Most mites are predatory and feed on smaller invertebrates.
Ecology: Assist in the regulation of communities by feeding on smaller prey.

Figure 11 ***a-g***. Araneae.

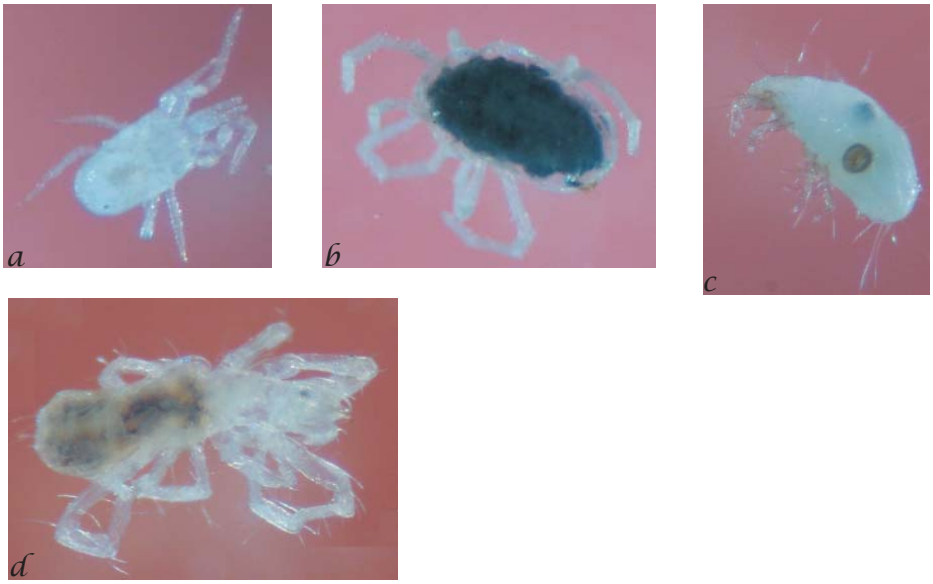

Figure 12 ***a-d***. Acarina.

Class: Diplopoda (Millipedes) and Chilopoda (Centipedes) (Figure 13 a-c)

Order: LITHOBIIDA
GEOPHILIDA
JULIDA
SPIROSTREPTIDA
SPIROBOLIDA

Total abundance: 162
Total diversity: 12
Average size: Specimens collected ranged from approximately 2 - 5cm in length.
Millipedes and centipedes are similar-looking animals, the main difference is that millipedes have two pairs of legs per body segment while centipedes have only a single pair. Their names reflect this difference as millipede means 1000 legs and centipede means 100 legs.
Habitat: Often found under logs and in leaf litter.
Primary role: Most millipedes are decomposers and feed on rotting organic matter. Centipedes are mainly predatory and feed on a wide range of other invertebrates.
Ecology: Assist in the breakdown of organic matter and with the aeration of soil.

Class: Collembolla (Springtails)

Order:ARTHROPLEONA (Entomobryidae) (Figure: 14a-e)
SYMPHYPLEONA (Sminthuridae) (Figure 15 a-e)

Total abundance: 19694
Total diversity: 26
Average size: Specimens collected ranged from approximately 1mm - 10mm.
Habitat: Most species are found in decomposition habitats such as decaying plant material. Some species are found on grasses, or under rocks and bark. Springtail abundance is highly increased with relative humidity and they are often seen floating on top of pools following heavy rain.



Figure 13 ***a-c.*** *a* Centipede; *b* Diplopoda ; *c* Diplopoda.





Figure 14 ***a-b.*** Juvenile ; ***c-e*** Entomobryidae.

Primary role: Most springtail species feed on the micro-organisms associated with decomposing organic matter. They also feed on plant material.
Ecology: Most springtail species feed on the micro-organisms associated with decomposing organic matter (eg fungi).

Coleoptera (Beetles) (Figures: 16 *a-f* and 17 *a-f*)

Total abundance: 983
Total diversity: 61
Average size: Specimens collected ranged from approximately 2mm - 30mm.
It is estimated that about 30% of all animal species in the world are beetles. Beetles have been able to inhabit almost all types of habitat from freshwater to dry land, including some parasites. Beetles have a tough covering ('elytra') for the abdomen and hind wings. This cover acts like armour and aids the progress of beetles into harsh environments. A Beetles life cycle consists of different stages, including eggs, larvae, pupae and adults. During the larval stage the animals are at their most vulnerable with little protection and limited movement. The abundance and diversity of beetles and their larvae can be strongly influenced by temperature and soil moisture.
Habitat: Beetles can be found in almost every available terrestrial habitat.
Primary role: Some beetles feed on plant tissue, others are predators.
Ecology: The Coleopteran families consist of beetles in a diverse range of functional groups including; predators, pollinators, herbivores, decomposers and parasites.

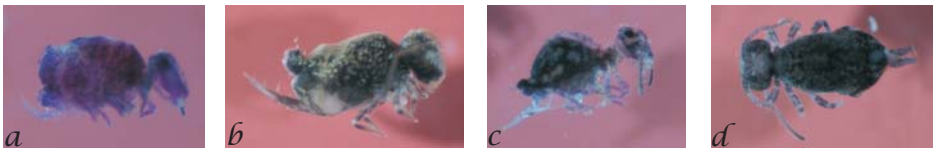

Figure 15 ***a-d.*** *a* Sminthuridae.

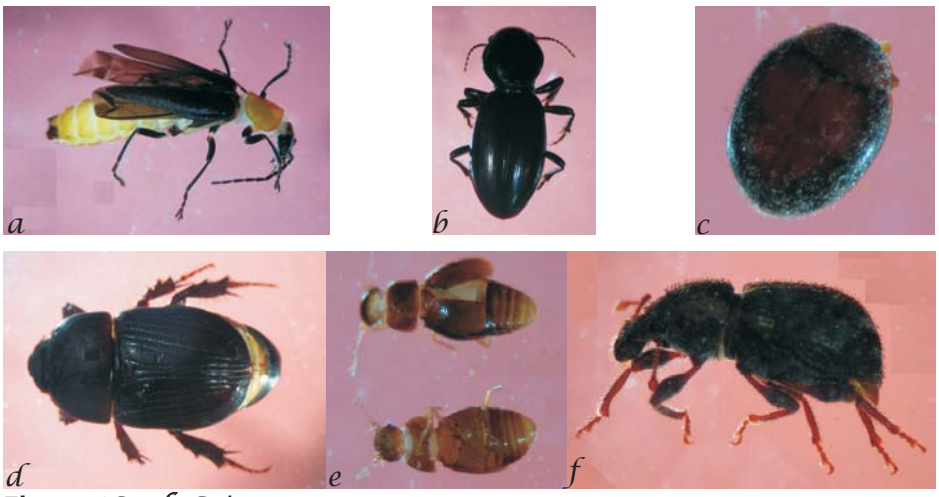

Figure 16 ***a-f.*** Coleoptera .

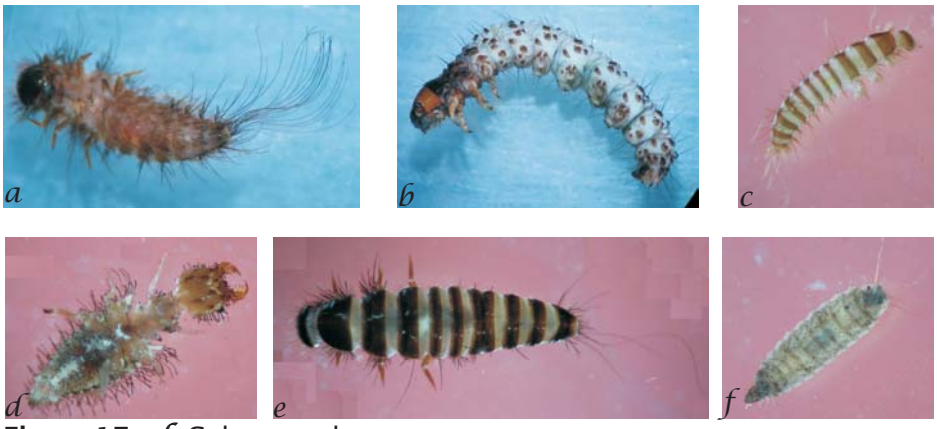

Figure 17 ***a-f.*** Coleoptera larvae .

Hymenoptera (Bees, wasps and ants)

Family: Formicidae (Ants) (Figure: 18 *a-h*)

Vespidae (Wasps) (Figure:19 *a-b*)

Total abundance: 5285
Total diversity: 68
Average size: Specimens collected ranged from approximately 2mm - 3cm.
The Hymenoptera is a large, diverse group and, is one of the most evolutionary advanced insect groups. They are usually found living in communities and have different castes responsible for different duties within the community. Animals in the Hymenopteran order can be easily distinguished by their very narrow 'waist', and two pairs of wings (for flying animals).
Habitat: Hymenopterans occur in soil and leaf litter, on vegetation, flying actively or drifting in air currents, or nesting in man-made environments.
Primary role: Feed mostly on plant material. Some species are predators or parasites.
Ecology: Larvae of some species can tunnel in wood or soil, others are parasitic. Hymenopteran adults are one of the most important pollinators and assist in the survival and success of many plant species. Most species assist in soil and nutrient regulation and assist in the reconstruction of soil structure.

Figure 18 *a-h.* Hymenoptera .

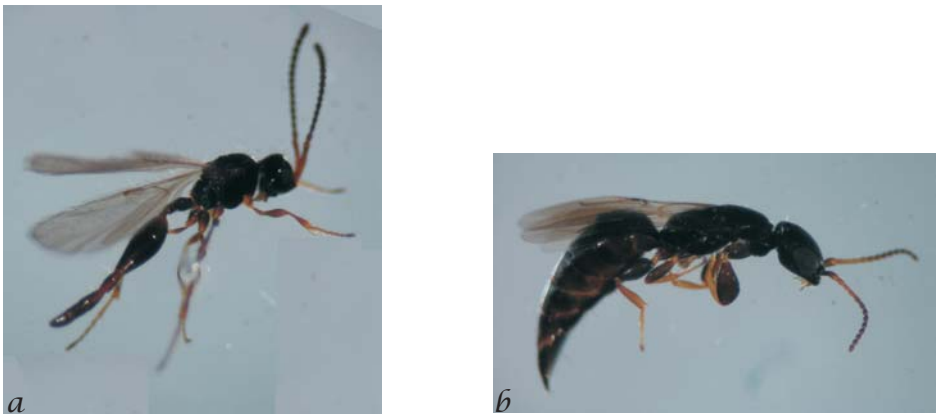

Figure 19 *a-b.* Hymenoptera vesp.

Other Invertebrates Collected

Haplotaxida (Worms)

Total abundance: 23
Total diversity: 1

Pseudoscorpionida (Pseudoscorpions)

(Figure: 20 *a-b*)
Total abundance: 87
Total diversity: 6

Isopoda (Slaters)

Total abundance: 2
Total diversity: 2

Blattodea (Cockroaches) (Figure 21 *a-b*)

Total abundance: 42
Total diversity: 8

Isoptera (Termites) (Figure: 22*a-c*)

Total abundance: 404
Total diversity: 10

Orthoptera (Grasshoppers) (Figure: 23*a*)

Total abundance: 6
Total diversity: 6

Phthiraptera (Lice)

Total abundance: 1
Total diversity: 1

Hemiptera (True bugs) (Figure: 23 *b*)

Total abundance: 89
Total diversity: 13

Thysanoptera (Thrips)

Total abundance: 30
Total diversity: 10

Dermaptera (Earwigs)

Total abundance: 11
Total diversity: 2

Diptera (Flies) (Figure: 23 *c*)

Total abundance: 171
Total diversity: 26

Lepidoptera (Moths) (Figure: 23 *d*)

Total abundance: 17
Total diversity: 6

Figure 20 *a-b.* Pseudoscorpionida .

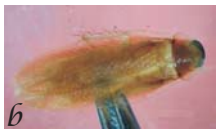

Figure 21 *a-b.* Blattodea.

Figure 22 *a-c.* Isoptera.

Figure 23 *a-d.* *a* Grasshopper; *b* Hemiptera; *c* Diptera ; *d* Moth.

Results

Results indicated that the pitfall trap method of collection was representative of more complex sampling regimes and was sufficient to assess the succession of cryptozoan communities with respect to restoration age. The abundance and diversity of cryptozoa was highest in sites with 2-3 year old vegetation, and as vegetation age increased the abundance and diversity decreased (see Figures 24 and 25).

Conclusion

The response of cryptozoa communities in this study were driven by two parameters;
(1) vegetation age AND
(2) change in moisture content with sampling date.

From this study we are not able to distinguish whether cryptozoa communities are solely influenced by vegetation age or climatic conditions.

Increased abundance of cryptozoa in younger sites may have been influenced by disturbance events in and around those sites. Disturbance such as ripping, introduction of new environment, weed and pest control and fertilization can affect the distribution of some animals (in this case invertebrates). This phenomenon is discussed within the "intermediate disturbance hypothesis" (read more about this theory in Connell, 1978 and/or Connell and Slatyer, 1977).

Further samples were taken in late September and in December from the same sites that Rachael had used earlier in the year. Unfortunately the data from these collections has not yet been processed. However, visual assessments of samples collected suggest an increase in abundance and diversity of cryptozoa in more mature sites (Figure 26). The

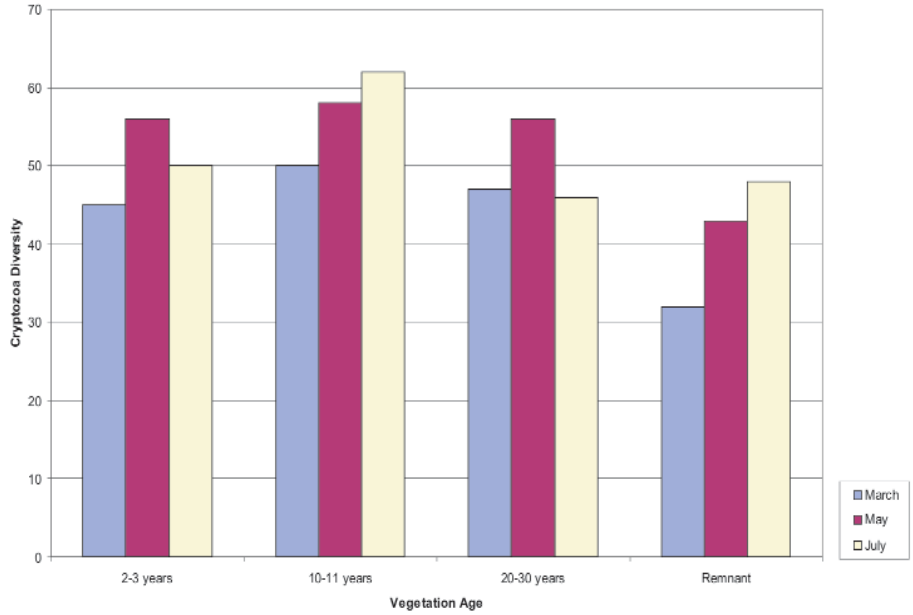

Figure 24 Diversity of Cryptozoa with respect to restoration age.

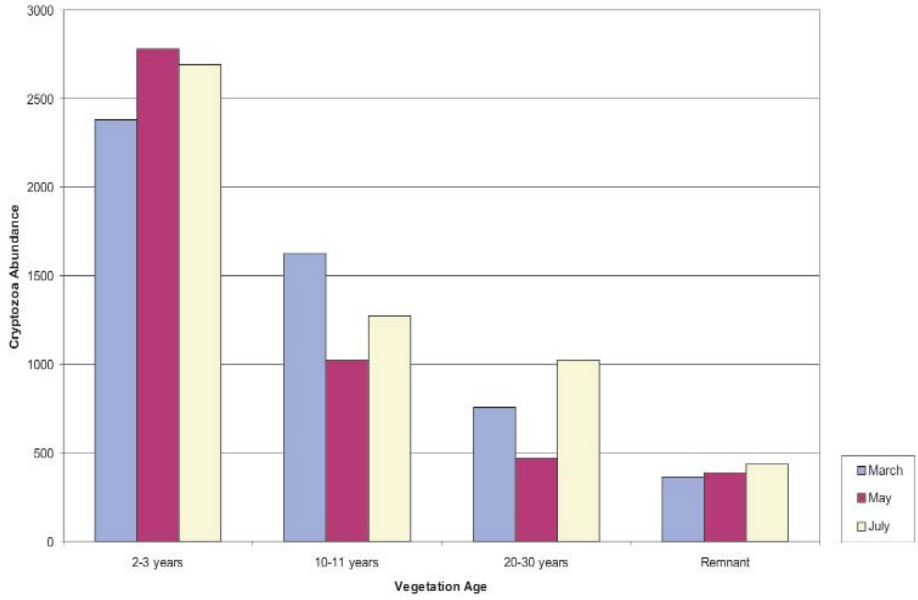

Figure 25 Abundance of Cryptozoa with respect to restoration age.

samples shown in Figure 26 were taken in December following an increase of rainfall in Northeast Victoria (Figure 27). This suggests the results shown in Rachael's study were highly impacted from low rainfall and that in more consistent years (i.e. with more rainfall) results may indicate that the abundance and diversity of cryptozoa will increase with the age of vegetation.

Implications of this study suggest that further investigation is required to assess whether cryptozoa in different aged restoration sites were influenced by disturbance, or distance to nearest edge, or whether the results found in the Byawatha Heartlands in 2003 were a response to extreme weather conditions experienced in previous years. Following this, extended studies could observe the relationship of cryptozoa with drought and seasonal disturbances.

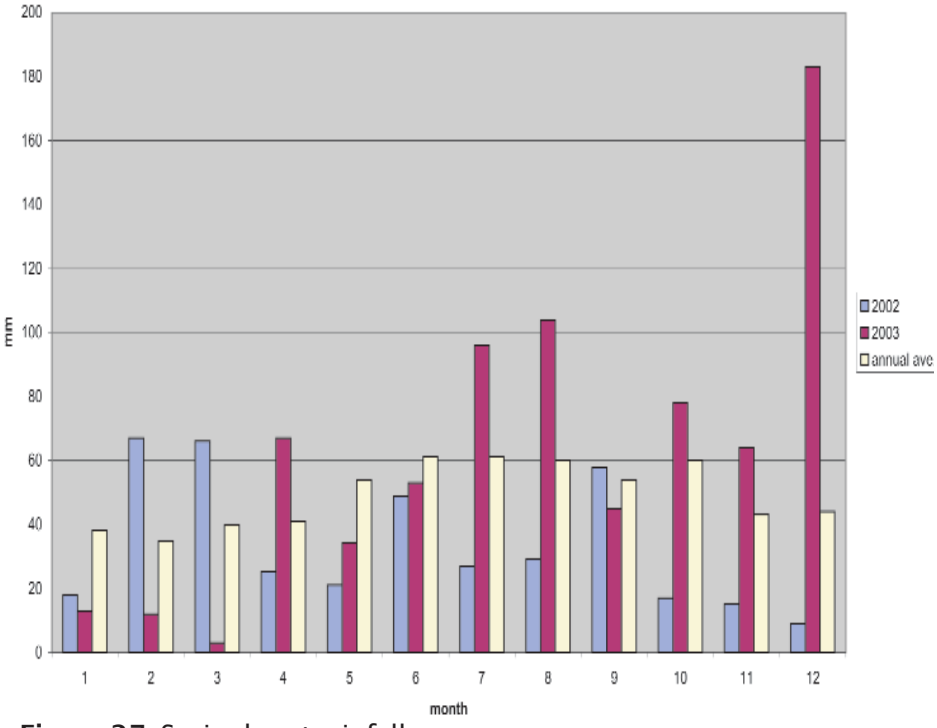

Figure 27. Springhurst rainfall

Figure 26. Pitfall trap samples obtained from sites discussed previously (Pages 10-12) in December 2003 by Dr Phil Suter.

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Glossary

Abundance the amount or number.
Cryptozoa soil and leaf litter invertebrates (crypto- secret, hidden, or concealed). Cryptozoan (plural).
Distance to nearest edge the distance of each sample from the nearest edge, that is a fence or a break in vegetation, was measured in meters at the time of sampling.
Diversity the number of different objects or species.
Invertebrate any animal lacking a backbone, including all species not classed as vertebrates.
Litter extraction a $0.25m^2$ quadrate was used to take standardized quantities of leaf litter for extraction of invertebrate material in tulgren funnels.
Litter moisture to obtain the wet weight of litter, each sample was weighed prior to extraction in the tulgren funnels. Following extraction, samples were air-cooled and weighed to obtain the dry weight. Moisture content was derived from the moisture content equation.
Moisture content equation

$$\text{Percentage (\%) moisture content} = \frac{(\text{Wet weight (g)} - \text{Dry weight (g)})}{\text{Wet weight (g)}} \times 100$$

Morphospecies a type of rapid identification, after individuals are identified to at least Order level, different species are identified as different morphospecies.

Pitfall trapping Pitfall traps were made up of test tubes slotted inside 20mm sleeves of electrical tubing. Traps were placed in the ground so the opening was even with the soil surface. Each pitfall trap contained approximately 10mL of 50% ethanol, 45% ethylene glycol and 5% glycerol preservative.

Remnant a surviving trace or vestige; remaining vegetation that has not been removed since settlement.

Soil moisture a metal pipe approximately 5 cm in diameter was pushed 10 cm into the ground, and soil was extracted. Samples were then placed into airtight bags and taken back to the laboratory for the determination of water content. **Moisture conten**t was derived from the moisture content equation.

Tulgren funnels method of extracting invertebrates from litter; when litter is heated and dried cryptozoa retreat to the bottom of the litter, drop through the mesh and into 75% ethanol preservative.

Vegetation structure vegetation was placed into one of three categories; (1) ground cover, <1 m tall, (2) under-story was from 1-5 m and (3) canopy cover was >5 m.