A comparison of the Coleoptera, Araneae and Formicidae fauna in a grazed native grassland remnant of Victoria

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A native grassland remnant on private property on the Western Basalt Plains of Victoria was investigated to determine the composition and relative abundance of the Formicidae (ant), Coleoptera (beetle), and Araneae (spider) fauna. One hundred and sixty morpho-species were identified, comprising 26 ant, 90 beetle and 44 spider morpho-species. Dominant ant, beetle and spider morpho-species, as well as functional groups, are described. The effect of grazing on the ant, beetle and spider invertebrate richness and relative abundance was examined from randomly established plots. Changes in structure, biomass and botanical composition, as reflecting grazed and ungrazed plots, were used to investigate if there were any effects on the invertebrates. The removal of grazing did affect certain dominant species of ants, beetles and spiders. There were no significant changes in the ant functional groups, however, there were significant changes observed for certain functional groups of beetles and spiders. The most effective management for the maintenance of these grasslands as invertebrate species-rich remnants would be to maintain the current domestic grazing levels and intensities. This will be appropriate if the objective is to maintain the current number of species within these grassland remnants.

INTRODUCTION

Invertebrates are quite often overlooked as to their biological significance. It is common for experimental work to examine the effects of management on the native flora and occasionally on the vertebrate fauna, but it is quite uncommon to examine such effects on the most abundant and diverse component of the ecosystem, the invertebrates.

Native grasslands were once extensive over the Western Basalt Plains of Victoria (830 000 ha), but now only 1 500 ha (0.2%) remain (Lunt 1991). Many of the remaining areas are florally species-poor and heavily disturbed and only a few exist which appear to be representative of the former native grasslands. Because most native grassland remnants are on private property, they are all grazed by sheep and/or cattle. The effect that grazing has on the species composition and abundance of invertebrates is poorly understood. This study sought to investigate the composition and abundance of the ant, beetle and spider fauna and the effects of grazing and its cessation on the invertebrates of native grasslands.

MATERIALS AND METHODS

Study site

The study site was located within 300 ha of native grassland on freehold land in the Western Basalt Plains, 40 km south of Ballarat. The site has been managed for sheep production and has never been cropped or otherwise subject to broadscale soil disturbance. The stocking rate for the grassland is low for this area, at 2.5 dry sheep equivalent per hectare (DSE/ha) (I. Taylor, Landholder "Warrambine" Western Basalt Plains, pers. comm.).

Invertebrate sampling and identification

Sampling for ants, beetles and spiders was by the use of pitfall, sweep net and hand-searching techniques. Sampling occurred for a five day period and was conducted twice for each season, over two years (1995–1996).

All invertebrates trapped were sorted, but only the ants, beetles and spiders were used for this study. These three invertebrate groups were identified to morpho-species level using CSIRO (1991) to determine the taxon to family level and, for further level of identifications Greenslade (1979) and Andersen (1991) for ants, Matthews (1980–1992) for beetles, and Davies (1986) for spiders. All morpho-species have been sent to the Museum of Victoria for verification. Each invertebrate group was also classified into a functional group based on feeding and behavioural characteristics based on information from Neumann *et al*. (1995) and CSIRO (1991) (beetles), Andersen (1991, 1995) (ants) and Main (1981) and Clyne (1969) (spiders).

Study plot

Twenty plots were randomly selected across the paddock. Ten were randomly chosen to

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be ungrazed and fenced out, using ringlock and chicken wire, to stop both sheep and rabbit grazing. The remaining ten plots were the control grazed plots. Plots were 6 m × 6 m and spaced from one another by at least 10 m. Sheep grazing throughout the whole paddock was used as the preferred grazing treatment, since this reflects the traditional management of the paddocks (Foreman 1996). Although the stocking rates varied slightly over the two years there was consistency in the regular removal of stock during spring. Stock was not greater than three DSE/ha.

Four 225 ml plastic cups were placed in the approximate centre 1 × 1 m grid of each of the larger 6 × 6 m plots. Cups were placed in the corners of this grid and dug into the ground with the lip level to the soil surface. Traps were left for one week before sampling to avoid any "digging-in" effects (Greenslade 1973). For each sampling period, 50–100 ml of 75/5 alcohol/glycerol was poured into each trap. Trapping (sampling) occurred for a five day period and was conducted twice for each season, over two years.

Within each plot, habitat variables were measured to assess the changes and differences in floristic composition, structure and biomass for the grazed and ungrazed plots.

RESULTS

Invertebrate composition

There were 160 arthropod morpho-species comprising ants (26), beetles (90) and spiders (44). Ant morpho-species from the genus *Iridomyrmex* were extremely abundant, with one morpho-species contributing almost half of the total ant population observed. Morpho-species from the genus *Pheidole* were also well represented (Table 1). There was a significant decrease (p = 0.05) in the relative abundance of the two most abundant morpho-species of *Iridomyrmex* when grazing was removed. The *Rhytidoponera* morpho-species increased in the ungrazed areas.

Table 1. Dominant ant fauna of a grazed native grassland with response in numbers of individual ants following removal of grazing.

Morpho-species	% Contribution to total numbers	Response
Iridomyrmex sp. *B*	48	decrease
Iridomyrmex sp. *E*	18	decrease
Pheidole sp. *C*	10	nil
Pheidole sp. *A*	9	nil
Rhytidoponera sp. *A*	7	nil
Iridomyrmex sp. *C*	4	nil
Iridomyrmex sp. *D*	2	nil

The majority of dominant beetles tended to be small, with body sizes ranging from 1–3 mm. Morpho-species of the Anthicidae and Curculionidae were abundant (Table 2). There was a significant decrease (p = 0.05) in the relative abundance of the three most common morpho-species. One of each of the curculionid and phalacrid morpho-species showed a significant increase in relative abundance in the ungrazed plots.

Table 2. Dominant beetle fauna of a grazed native grassland.

Morpho-species	% Contribution to total numbers	Response
Anthicidae sp. *A*	25	decrease
Pselaphidae sp. *A*	20	decrease
Anthicidae sp. *B*	13	decrease
Curculionidae sp. *A*	12	increase
Anthicidae sp. *C*	8	nil
Curculionidae sp. *B*	6	nil
Staphylinidae sp. *A*	6	nil
Melyridae sp. *A*	6	nil
Phalacridae sp. *A*	2	increase

Morpho-species of Lycosidae were abundant with one contributing half of the total number of spiders observed. Salticidae were also well represented (Table 3). There was a significant decrease (p = 0.05) in the relative abundance of the two most abundant morpho-species: a lycosid and salticid.

Table 3. Dominant spider fauna of a grazed native grassland.

Morpho-species	% Contribution to total numbers	Response
Lycosidae spp. *A*	50	decrease
Salticidae spp. *A*	15	decrease
Ctenidae spp. *A*	10	nil
Salticidae spp. *B*	10	nil
Lycosidae spp. *B*	9	nil
Miturgidae spp. *A*	4	nil

Functional groups

Ants: The ant species were grouped as feeding and behavioural types, based on Andersen (1995). In the grazed plots, abundance of the Dominant Dolichoderinae, particularly *Iridomyrmex* spp. was high (Table 4). The next most abundant group was the Generalized Myrmicinae, with *Pheidole* spp. being the most prominent. The Opportunist group, containing *Rhytidoponera* spp. and the Hot Climate Specialist *Melophorus* spp. were sub-dominant in abundance. There were only minor contributions to the ant assemblage from species of other functional groups, including Subordinate Camponotini and Cold Climate Specialists.

In the ungrazed plots there were to be only minor changes in the relative abundances of the ant functional group assemblage and there was no significant change in dominance. There was a drop in the abundance of certain *Iridomyrmex* spp. in the ungrazed plots (as shown previously), leading to a decrease in the abundance of the Dominant Dolichoderinae group. The Generalized Myrmicinae also fell in abundance in both grazed and ungrazed plots. The *Rhytidoponera* spp., the Opportunist group, increased in relative abundance in the ungrazed plots. The Hot Climate Specialists (mainly from *Melophorus* spp.) fell in abundance in the final year on the ungrazed plots.

Beetles: The beetle species are grouped as feeding types, based on Neumann *et al.* (1995). The more common and dominant families in the functional groups were: predators (Pselaphidae, Carabidae and Staphylinidae); decomposers (Anthicidae); herbivores (Curculionidae); fungus feeders (Phalacridae) (Table 4). Numerous other families were represented, but in relatively low abundance.

In the ungrazed plots, there were only minor changes in the relative abundances of the functional groups, but the same families showed dominance. The decomposers (represented mainly by the anthicids) decreased in relative abundance in the ungrazed plots. The predators showed a varied response, dominant groups of the pselaphids decreased and the staphylinids increased, while the carabids were variable. In general the herbivores showed no changes in relative abundance, although the curculionds increased slightly. There was an increase in the numbers of fungus-feeders, particularly the phalacrids, in the ungrazed plots.

Spiders: The spiders are grouped as behavioural groups, based on Main (1981) and Clyne (1969). In the grazed plots, hunting spiders dominated the assemblage, with major contributions from the ground-dwelling hunters (family Lycosidae) and nomad hunters (families Salticidae and Thomisidae) (Table 4). There was a very low abundance of all aerial web-building groups.

In the ungrazed plots, the hunting spiders also dominated the assemblage, and there was no change in the abundances of the ground-dwelling hunters. There were increases in the majority of families of nomad hunters in the ungrazed plots. There was an increase in the numbers of sheet-web weavers, particularly from the family Linyphiidae. On the grazed plots, there were virtually equal contributions to the assemblage from predators, herbivores and decomposers.

Table 4. A comparison of grazed and ungrazed plots using percentage contribution of each functional group of ants, beetles and spiders.

Functional Group	Grazed	Ungrazed
FORMICIDAE		
Dominant Dolichoderinae	68	51
Generalized Myrmicinae	20	24
Opportunist	6	17
Hot Climate Specialist	4	5
Subordinate Camponotini	1	1
Specialist Predator	1	1
Cold Climate Specialist	—	1
Total	100	100
COLEOPTERA		
Predators	37	38
Herbivores	23	26
Decomposers	35	20
Fungus Feeders	5	16
Total	100	100
ARANEAE		
Nomad Hunters	37	62
Ground-dwelling Hunters	57	23
Sheet-web Weaver	4	11
Orb-weaver	1	3
Cobweb Weaver	1	1
Total	100	100

Floristic composition, structure and biomass

There was a significant difference in the number of herb species in the ungrazed plots, as the dominant native grass Kangaroo Grass *Themeda triandra* became dense and structurally closed over the two years, with no bare ground at the end of the study period (Table 5). Average total biomass in the ungrazed plots was significantly higher than in the grazed plots. Plots produced most green feed in the spring and summer.

DISCUSSION

The ant, beetle and spider invertebrate fauna of this remnant grassland appears to be

Table 5. Habitat variables measured during spring. Species Richness = total plant number; Cover = Percentage cover of native grasses; Biomass = Total Biomass; G = grazed, U = ungrazed (numbers in bold = signficant difference).

Habitat Variables	1994		1995		1996	
	G	U	G	U	G	U
Species Richness	30.3	29.5	**29.4**	**22.4**	**30.6**	**21.8**
Cover (%)	31.8	32.2	**36.5**	**62.9**	**35.5**	**80.1**
Biomass (kg/ha)	232	204	**342**	**1 696**	**718**	**3 575**

rich, supporting results from the few other grassland areas that have been studied. Yen (1994) found 67 species of beetles and 43 species of ants from 12 grassland remnant sites on the Western Basalt Plains. Miller and New (1995) found 36 species of ants on one grassland area near Mount Piper. Those studies were of a shorter duration than the current research but it might be expected that a longer investigation at those sites would detect more species, simply on a species-accumulation basis. A similar number of morpho-species of ants, beetles, and spiders was present on this grassland remnant on the Western Basalt Plains of Victoria. It indicates that grasslands of the Western Basalt Plains are rich and diverse in terms of the forgotten fauna — the invertebrates.

The Western Basalt Plains grassland contained 26 morpho-species of ants; seven of which were dominant. *Iridomyrmex* spp. were well represented, contributing to over half of the ant fauna observed. Other species that were well represented were in the genera *Pheidole* and *Rhytidoponera*. The two most common ant morpho-species decreased in relative abundance in the ungrazed plots, with the remaining five dominant ant morpho-species showing no change in response to grazing removal. The decrease in the two dominant *Iridomyrmex* spp. related to changes in the vegetation described. The dense growth of the native tussock grass *T. triandra* created a completely closed structure, which appeared to restrict the competitive ability and activity of the *Iridomyrmex* spp. Of the other five dominant ant morpho-species, one, the opportunist *Rhytidoponera* sp., tended to increase in ungrazed plots. This genus is often used as an indicator of disturbance (Andersen 1995) and this increase in relative abundance in the ungrazed plots may indicate that the removal of grazing created a disturbance to which this species was responding. The increase may have also been due to a decrease in the two dominant *Iridomyrmex* spp., because it has the ability to increase in numbers when other ant morpho-species in the matrix are suppressed by other factors.

There were 90 morpho-species of beetles on the Western Basalt Plains grassland. However, only nine contributed significantly to the beetle fauna composition. The majority of the dominant morpho-species of beetles were small, most being 1 to 3 mm long. These were predominantly from the families of Anthicidae, Pselaphidae and Staphylinidae. Their existence in high numbers in such a small area suggests the possibility of extremely high numbers of beetles in unsurveyed native grasslands. The two curculionids that were dominant were both large and may have a considerable effect, as herbivores, on the native grasses and herbs. The three most dominant beetle morpho-species all decreased with the removal of grazing. This may be attributed to their size and the observed changes in the vegetation structure. Being small, predatory species, tussocks with numerous, open inter-tussock spaces may enable such species to prey upon the microscopic soil fauna. With the significant loss of bare ground in ungrazed plots, the ability of these small predators to manoeuvre through the grassland, and hence capture prey, may be reduced. An increase in one of the dominant curculionids was not surprising, because it is a herbivore, and with a dramatic increase in tussock grass vegetation, this morpho-species would be favoured. There was also a significant increase in the dominant phalacrid morpho-species. This was perhaps related to an increase of the cryptogamic layer in the absence of grazing and the dramatic changes in temperature and humidity observed among the tussocks during sampling.

There were 44 morpho-species of spiders identified from this Western Basalt Plains grassland, six of which were dominant. The Lycosidae (Wolf Spider) family contributed almost half the total spider fauna observed. Small, nomadic hunters — Salticidae, Ctenidae and Miturgidae — also contributed strongly, highlighting the complete dominance of hunting spiders in this grassland. With the removal of grazing, morpho-species showed no changes in relative abundance. The two most dominant spider morpho-species showed a trend of decrease in relative abundance. The reduction in the two most common hunting spiders may be related to the closing of the tussock structure, because ground-dwelling hunters, in particular, require bare ground to facilitate capture of their prey. Although not showing dominance, morpho-species from the family Linyphiidae (sheet-web weavers) were easily detected in the ungrazed plots in the second year. This was almost certainly related to the increase in aerial vegetation.

On the Western Basalt Plains, the most abundant functional group of ants on both grazed and ungrazed plots were the Dominant Dolichoderinae group, in particular, species of *Iridomyrmex*. These highly active, abundant and aggressive (group of) species exert a major competitive influence on other ants. They are particularly abundant and diverse in hot, open areas such as grasslands. They are typically dominant and high in abundance in semi-arid communities (Bromham 1994). The next most abundant group, the Generalized

Myrmicinae are ubiquitous and are often abundant in Australian ant communities (Andersen 1995). The Opportunist group was higher in ungrazed plots; they are ruderal (basic) species and are usually characteristic of sites where stress or disturbance severely limit ant productivity and diversity (Andersen 1995).

The Hot Climate Specialist group made up a small part of the ant assemblage and were frequently found in areas where there were high numbers of the Dominant Dolichoderinaes. This group has a range of physiological, morphological and behavioural specializations related to their feeding ecology, which reduces their interactions with other ants. Species of *Melophorus* (which were well represented) are highly thermophilic, foraging when few or no other ants are active (Andersen 1995). Minor contributions were made to the Western Basalt Plains ant fauna from the Cold Climate, Opportunist, Specialist Predator and Subordinate Camponotini groups. All of these groups are usually recorded in low numbers in mesic environments (Andersen 1995).

The beetle fauna of the Western Basalt Plains site was composed largely of predatory, herbivorous and decomposer species, typically from the families Anthicidae (decomposer), Curculionidae (herbivore) and Staphylinidae, Pselaphidae and Carabidae all predators. These three predator families are typically common in all Australian environments and play a major role in structuring the invertebrate assemblage. In particular, staphylinids and pselaphids prey on ants, mites and collembola (Matthews 1982). The carabids are not as selective and prey on many arthropods, being nocturnal hunters (Matthews 1980). The single abundant decomposer present was from the family Anthicidae; this family is probably responsible for the high litter turnover. The herbivores comprise the other major component of the grassland beetle fauna and were mainly from the Curculionidae (weevils). They are browsers but their effects on the vegetation is unknown, although they may have a significant effect on the structure of native grasslands. Fungus feeders were less common in this grassland. This may be a result of the reduced number of cryptogamic plant and fungi that are able to grow in grazed grasslands. Their increase after the removal of grazing was probably due to the less trampled soil surface, which permitted the establishment of cryptogams. The increase in herbivores (curculionids) may have been related to the increase in grass cover and structure. The increase in certain predators (staphlinids) may be related to their predatory lifestyle and the relative abundance of microscopic invertebrates feeding on the vegetation.

Hunting spiders made up over half the spider fauna found in both the Western Basalt Plains. The low numbers of all aerial web-building families is probably related to the lack of aerial vegetation and hence vertical structure in the grazed grassland. The high numbers of ground-dwelling ants and beetles (and almost certainly other arthropod groups) allows for hunting spiders to be numerous and abundant in these grasslands. Weaving spiders were obviously encouraged by the vigorous growth of Kangaroo Grass on the Western Basalt Plains. The decline in the numbers of ground-dwelling hunting spiders at both sites following cessation of grazing could be related to the loss of open structure which resulted in the presence of fewer areas of bare ground on which to capture prey.

CONCLUSION

Because the site we investigated was on private property, grazing domestic stock will continue to be a part of the management of this native grassland. A conservation management approach is required and stocking rates and timing is vital for maintaining species richness and native grassland structure and function. This would be based on modest grazing regimes of 2 DSE per hectare in the Western Basalt Plains during summer and autumn. Stock should be removed from grassland areas during spring, to allow plants to set seed and establish.

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