Chapter Five

Lycosidae Movement Within-Fields and Seasonal Patterns of Activity.

Introduction

An individual field within a cropping region is surrounded by other fields of the same crop, other crop types, as well as non-crop vegetation. The abundance of arthropods within a field is determined by the emigration and immigration of arthropods to and from adjoining vegetation (crop or non-crop, see Chapters three and four) combined with within-field reproduction and survival (Johnson *et al.* 2000). The dynamic nature of a cropping system means that arthropod movement is continually occurring, often in response to the supply and removal of resources and changes in other habitat variables.

Movement of predators between adjacent and non-adjacent fields within a region is largely unknown. The majority of studies addressing this subject use indirect techniques and fail to include mark-release-recapture experiments or other direct techniques that quantify movement (table 1). Apart from the traditional mark-release-recapture techniques, detection of pollen may be used to determine the origin and movement of beneficial arthropods between foraging habitats (Yee 1998, Gregg *et al.* 1990). Yee (1998) identified potential habitats of eight predator taxa in cotton in the Namoi Valley and Darling Downs by sampling vegetation and identifying pollen found in or on predators. Many predators were recorded in wheat, barley, sunflower, and uncultivated weeds and grasses such as turnip weed (*Rapistrum rugosum*). Further data comes from studies on the potential of alternative vegetation as “trap crops” for *Helicoverpa* spp. and other pests (Mensah & Khan 1997) and refuges or nurseries for beneficials (Mensah 2002a,b, 1999, Walker *et al*. 1996). In order to promote nursery crops or non-crop refuges for beneficials as a pest management strategy the movement of insects from the source area into the target crop must be shown and quantified. The development of novel techniques for quantifying predator movement in the field requires greater attention, given the importance of dispersal and aggregation patterns for pest suppression.

In contrast, numerous studies provide a more detailed picture of *Helicoverpa* spp. movement between fields (Fitt & Pinkerton 1990), between areas within a region (Drake & Fitt 1990) and between regions (Fitt *et al.* 1990, 1992, Rochester 1999). The information available suggests that there is substantial movement of pests between fields, with little regard to defined property boundaries. On the Darling Downs, data on *Helicoverpa* spp. egg density in two focal areas has been mapped for cotton and grain crops. Areas of high egg density (2.7 eggs per plant) may extend for up to three kilometres and encompass more than one management unit (Rochester *et al.* 2002, Johnson *et al.* 2000). This suggests that it is unrealistic for each property, or crop type, to be viewed as an independent unit in terms of the arthropod assemblages present, and pest management practices implemented accordingly. Zalucki and Norton (1999) suggest that area wide, season long management plans are necessary for multivoltine, highly mobile, polyphagous pests, such as *Helicoverpa* spp. Such area wide pest management programs are currently being evaluated on the Darling Downs, Queensland (Tuart 1999, Twine 1991), and the area wide management of insecticide resistance is commonly practised (Shaw & Watson 2002). Similar programs for the area wide conservation and mapping of beneficial abundance have not been attempted.

Table 1. Techniques to quantify arthropod movement in agroecosystems

1. Mark-release-recapture	<u>Direct procedure</u>
Involves the marking of individuals, releasing the marked individual at a location and recapture of the marked individual in a new location after a known period of time. Marking agents include: Elemental markers (Akey 1991, Owain 2003) Enamel paints (Kiss & Samu 2000) Flourescent dust (Corbett & Rosenheim 1990, Narisu *et al.* 1999) Pollen (Yee 1998)	
2. Uni-directional traps	<u>Direct procedure</u>
Traps are gated in some way so that only arthropods travelling from a certain direction are captured. Pitfall traps (Duelli *et al.* 1990) Sticky traps (Owain 2003) Light traps	
3. Direct observation	<u>Direct procedure</u>
Direct observation of movement behaviour in the field combined with recording movement paths (Turchin *et al.* 1991). Radar observations (Drake & Farrow 1985)	
4. Sampling programs	<u>Indirect procedure</u>
Arthropods are sampled using a standard technique across area over a period of time. Movement is inferred from abundance patterns and species phenology (Rochester *et al.* 2002).	

Mark-release-recapture experiments

Mark-release-recapture (or resight) methods have been used to study the movement of a variety of arthropods. The marking agents used include radioactive isotopes, fluorescent dyes, waterproof inks, stick on numbers and paints and pollen (table 1). Many mark-recapture studies have focussed on wasp parasitoids of agricultural pests for analysis of feeding, movement, mortality and density (Hopper 1991). Parasitoids have been “marked” with immunoglobulins (Hagler & Jackson 1998), fluorescent dust (Corbett & Rosenheim 1996) and elemental labels (Hopper 1991). Narisu *et al.* (1999) used fluorescent powder to mark rangeland grasshoppers. The grasshoppers were then resighted at night with an ultraviolet light. Hagler (1997) compared immunoglobulin markers with fluorescent dust for marking Coccinellidae. They found that the immunoglobulin markers had a greater retention time than the dust. Fluorescent dyes have been used to mark insect eggs in predation studies using earwigs (Hawkes 1972). Some pests such as *Diabrotica virgifera virgifera* LeConte (western corn rootworm) have been marked with fluorescent powder (Oloumi-Sadeghi & Levine 1989), and *Helicoverpa* spp. have been marked with the heavy metal strontium (Fitt & Pinkerton 1990). Regardless of marking agent or subject it is crucial that the marking technique does not alter the behaviour of the study animal. Furthermore the marking agent must be easy to apply, easy to recognise and persist on the subject (Akey 1991).

Activity of unmarked male and female *Pardosa lugubris* (Walckenaer) was investigated by Vlijm and Richter (1966) in a 1.8 by 0.9 by 0.2 metre test container. It was found that when carrying young the activity of the females increased. Activity of the males peaked during the reproductive period. No measurements were made on distances travelled, and the high density of subjects in the arena may have had an impact on behaviour. Hallander (1967) marked *Pardosa chelata* (O.F. Müller) and *Pardosa pullata* (Clerck) males and females with cellulose paint and recorded their movements from a central release location. The males were found to be more active than females overall, and the females were less active when carrying cocoons and young. The maximum distance covered was 147m in 133 days (table 2). Dondale *et al.* (1970) found that the Lycosids of the genus *Schizocosa* could move across a meadow for straight-line distances greater than 85 metres in eight days.

These few studies have shown that the life stage and sex of the spider will influence its activity. Other factors such as prey availability, the understory habitat (Buddle & Rypstra 2003) and weather may have an effect on activity. Many other aspects of predator movement remain unstudied and mark-recapture techniques, although time consuming, can provide essential information. Here a mark-recapture study was used to examine the movement of Lycosidae spiders within a soybean field, and adjacent lucerne field. The seasonal pattern in within-field abundance of Lycosidae adults and immatures was investigated. I initially conducted a preliminary experiment to test if the marking agent influenced spider movement and life span.

Table 2. Straight-line distances travelled by spiders in a study by Hallander (1967) using mark-recapture techniques. Numbers in brackets indicate standard error of the mean.

Spider species	Sex	Mean distance travelled (m)	N	Day	**Mean distance (m/day)**
Pardosa chelata	M	21.90 (16.91)	21	151	**0.15**
Pardosa chelata	F	45.23 (29.82)	56	133	**0.34**
Pardosa pullata	M	7.94 (4.62)	17	40	**0.20**
Pardosa pullata	F	9.33 (8.25)	19	85	**0.11**

5.A Preliminary experiment

Does the marking agent (colored white out dots on cephalothorax) have any impact on spider life span, and behavior?

Materials and methods

Lycosidae were caught in empty pitfall traps in soybean fields over a number of weeks at the end of the 2000/01 season. The specimens were kept chilled whilst being transported to the laboratory and the collection date and location recorded. Each was measured (from the end of the abdomen, excluding spinnerets, to the tip of the cephalothorax), sexed and placed in a rectangular plastic container with a mesh lid. Two moist wicks and some dry soybean leaves were added to the container. Laboratory reared *H. armigera* larvae (first and second instar, n = 20) were supplied as food every three days. Various insects (aphids, leafhoppers, other Lepidoptera larvae) were collected by sweep netting in lucerne and fed to the spiders on an irregular basis. Half of the spiders collected were placed in the fridge for five minutes then removed and marked on the cephalothorax with a dot of coloured correction fluid (Liquid Paper, Gillette Australia Pty Ltd.). The other half were treated similarly but marked with water. All spiders where maintained until their deaths or for approximately 90 days.

The difference between the mean Lycosidae survival times for each treatment was tested using the statistical program S-Plus. A histogram showed that the survival time of the two groups of spiders was not normally distributed; therefore a Wilcoxon signed rank test was used compare the two means. The test was performed on the entire data set, excluding a single marked spider that died very soon after capture (eight days). This spider was considered an outlier. I reasoned it had reached near the end of its adult life span when it was captured and marked.

Results and discussion

Eight out of ten control Lycosidae survived to the end of the experiment, and five out of ten for marked Lycosidae. Control spiders had on average a longer life span (mean 75.3 days ± 4.58 standard error) than the marked spiders (53.4 days ± 10.46) (fig. 1). The difference in mean survival time between marked and control spiders was not significant (T = 1.50, P = 0.16). The low number of spiders (n = 10 per treatment) used in this experiment may have contributed to the difference in the means observed and a greater number of spiders per treatment may have made the conclusions stronger.

No conclusions can be drawn on the effect of the marking agent on behaviour because spiders were held in small containers. However, marked spiders were able to feed, move and moult successfully. Marked females produced and carried egg sacs. The marking agent was lost after moulting, and should only be used on adult Lycosidae to ensure the greatest retention time. The adult spiders were capable of living 90 days or longer regardless of the marking agent.

The use of correction fluid appears to have little affect on the survival time of Lycosidae used in this study. It is considered a useful marking agent for adult Lycosidae because it will be retained for a long time, is inexpensive, and can be applied easily in the field. However, other marking agents (e.g. fluorescent dusts, Corbett & Rosenheim 1990, Narisu *et al.* 1999) that were not assessed in this study may also prove useful.

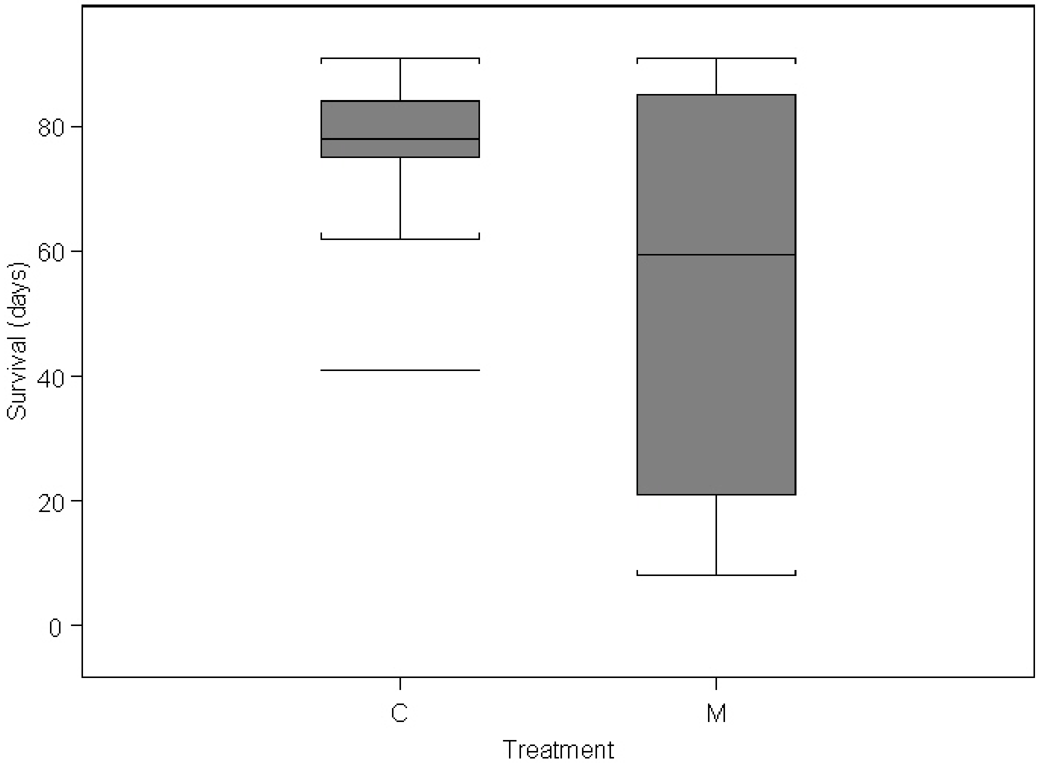


Figure 1. Box plot of the survival time of spiders marked with correction fluid on the cephalothorax (M, marked) or without marks (C, control). The line in the centre of the box plot represents the median with the tails showing the 95% confidence intervals and outliers represented by a single line.

5.B Within-field movement studies in soybean (2000/01, 2001/02).

The within-field seasonal abundance patterns of adult Lyscosidae were investigated using regular collections of spiders. Marking and releasing the collected individuals allowed an assessment of the within-field movement of Lycosidae. The following questions were addressed:

1. Can Lycosidae move across the lucerne/soybean interface?
2. What distances are Lycosidae capable of travelling within soybean fields?

Materials and methods

The within-field seasonal abundance of Lycosidae spiders was assessed within four soybean fields over two seasons. Pitfall trap sleeves (without the collecting cup, 7cm diameter) were placed in a grid pattern with 20 metres between traps and left out for the entire season. In Mendel (2000/01) there were 42 traps, Horti. (2000/01) 42 traps, Gilbert A (2001/02) 51 traps and Gilbert C (2001/02) 42 traps (see Chapter eight). These were checked every second or third day and any live Lycosidae that had fallen into the traps were collected in a small solo cup. Grid locations of all spiders caught in the traps were recorded. Adult spiders over 10mm in body length were marked and released, juvenile spiders were released at the site of capture and dead animals were removed from the trap. Adults were taken to a cold room (approximately 13^0C) and left for 10 minutes then sexed and their body length measured. Each spider was individually marked with dots of colored correction fluid on their cephalothorax. The colour, number and location of dots were different for each individual spider. The spiders were released back into the soybean field at the centre of the sampling grid.

Carabid beetles were abundant in the traps in the 2001/02 season and these too were marked and released. Dots of correction fluid were placed on the elytra of the larger beetles. Other arthropods (e.g. field crickets, cluster caterpillars) that had fallen into the traps were recorded but not removed. The lycosid spiders that fell into the traps often fed on them.

Results

At Horti field sampling ran from 20 February to 4 April 2001. A total of 211 spiders were caught in the traps and of these 88 where marked and released. Only four of the marked spiders where recaptured (4.5% recapture rate, table 3). The maximum straight-line distance traveled was 65m in 16 days, and this particular spider crossed from the soybean field into the adjacent lucerne field (across a grassy road). The average straight-line distance traveled by these four spiders was 3.2 (± 0.82 standard error) metres per day. Paths travelled by marked spiders were mapped (fig. 2). Due to the low numbers of recaptures no general trends were observed. Those traps closest to the release point caught three out of the four marked spiders.

In Mendel field sampling ran from 12 March to 26 March 2001. A total of 8 spiders were caught, with three being marked and released, and no re-captures. Sampling was stopped due to the very low capture rate. The data collected was not analysed further.

In the following season sampling in Gilbert C ran from 4 January to 12 March 2002. In total 52 Lycosidae were caught, of these 26 were marked and released. No spiders were recaptured. The majority of Carabidae caught were *Pheropsophus* sp. (Brachininae, bombadier beetles). Sixteen were caught, and of these six were marked and released and none were recaptured. Three individuals of a second, unidentified species of Carabidae were caught in the traps, of these two were marked and released and none recaptured.

Sampling in Gilbert A field ran from 24 December 2001 to 12 March 2002. In total 85 Lycosidae were caught, of these 51 were marked and released. No spiders were recaptured. A total of 43 *Pheropsophus* sp. were caught, and of these 16 were marked and released and none were recaptured in the grid pitfall traps. However, one marked beetle was found in a pitfall trap located next to the water traps in the centre of the field. This trap was filled with ethanol and open for seven days. If we assume the beetle was caught one day after it was released in the centre of the grid it traveled a straight-line distance of 45m in a single day. If it was not captured until the final day the trap was open, it would have traveled a minimum of 6.4 metres per day. Four individuals of the second species of Carabidae were caught in the traps, all were marked and released and none were recaptured.

In all fields, across both seasons the seasonal pattern of Lycosidae activity based on pitfall trap captures was similar. In Horti field activity was highest in the first half of the season and decreased in the second half of the season (fig. 3). In both Gilbert A and C (fig. 4 and 5) this trend was repeated, however the number of Lycosidae captured was lower. In all fields large rainfall events were sometimes followed by a decrease in activity. Seasonal activity of adult and immature Lycosidae was separated for the Horti field data (fig. 6). Immature Lycosidae displayed a wave-pattern that decreased as the season progressed. Male Lycosidae activity was greatest in the first half of the season and decreased dramatically in the second half and female activity was variable but showed slightly greater activity in the first half of the season (fig. 6).

Not all traps within the grid caught the same number of Lycosidae, so the spatial pattern in trap catch was investigated. In Horti. field site (fig. 7) the traps within the lucerne captured high numbers of Lycosidae, and traps 50m to 90m away from the lucerne interface caught the most Lycosidae. In both Gilbert A and Gilbert C the Lycosidae were most active within the lucerne field (fig. 8). Activity decreased with distance from the interface. The greatest catches in the soybean fields were found in those traps 10m away from the interface. In Gilbert A the sampling grid was extended to the weed margin approximately 150m from the soybean/lucerne interface and the activity of Lycosidae within the weed margin was higher than in the soybean field.

Table 3. Re-captures of marked Lycosidae in soybean field (Horti. 2000/01) that was adjacent to lucerne (see fig. 2 for capture locations).

Sex[1]	Body length (mm)	1st Capture date	Grid location at 1st capture	2nd Capture date	Grid location at 2nd capture	Days between capture	Min. distance moved (m)	**Distance travelled per day (m/day)**
F	17	26.02.01	20,80	28.02.01	40,60	2	10	**5**
M	12	20.02.01	100,20	8.03.01	80,0	16	65	**4.1**
M	10	8.03.01	20,120	12.03.01	40,60	4	10	**2.5**
F	16	6.03.01	40,60	23.03.01	40,40	17	22	**1.3**

[1] F: female, M: male.

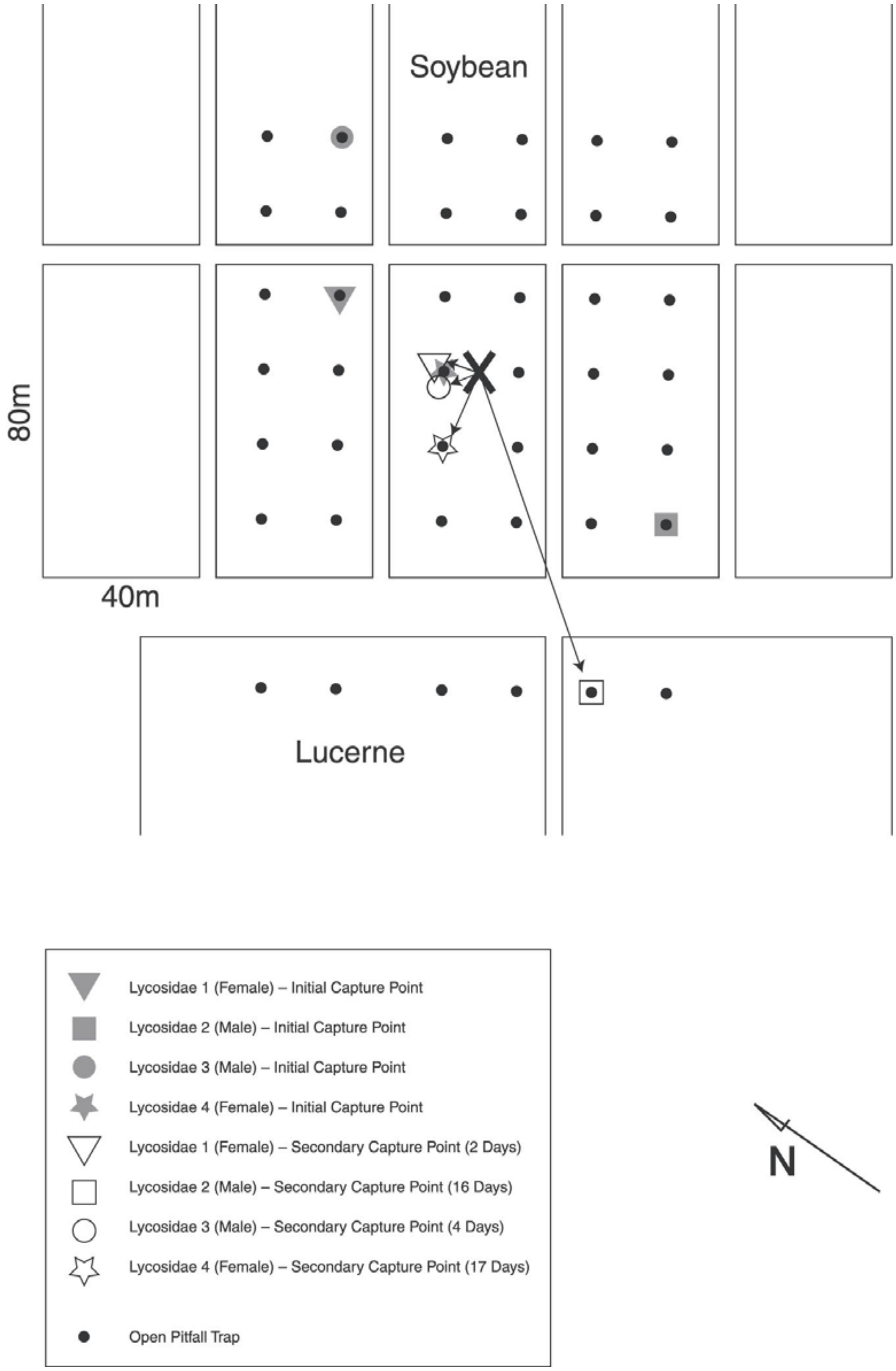


Figure 2. Map of recaptures of marked Lycosidae in soybean field Horti. (2000/01). The shaded shapes represent the initial trap in which the spider was caught. The open shapes shows where the spider was subsequently caught, after being marked and released from the centre of the grid. The number of days in brackets in the legend indicates the time between primary and secondary capture.

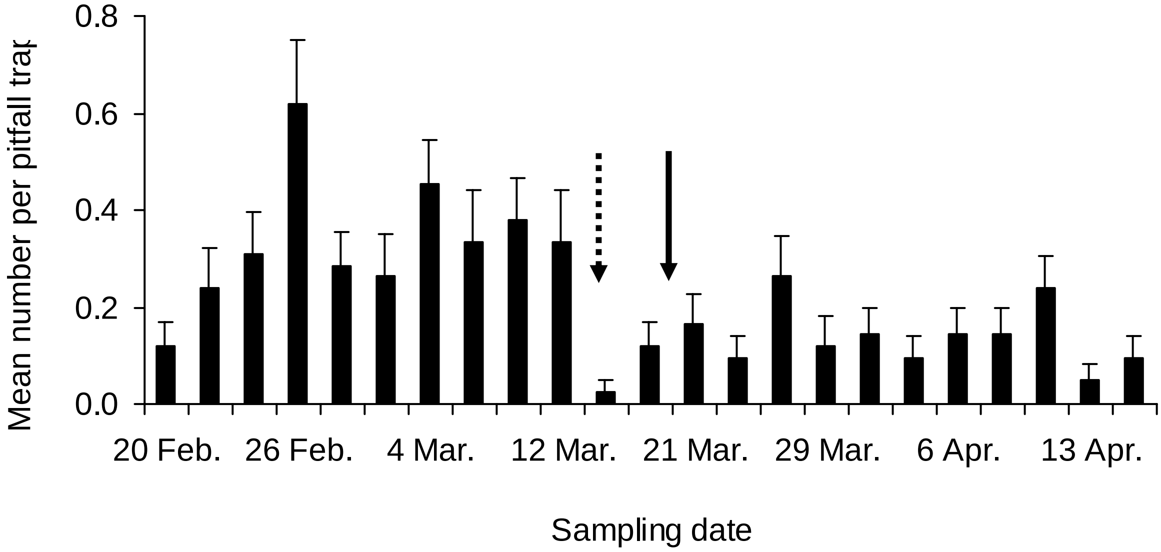


Figure 3. Seasonal pattern of Lycosidae activity in a soybean field Horti. (2000/01) as measured in pitfall traps. Bars indicate standard error. Solid arrow represents when an insecticide spray was put on some areas of the soybean field. The dashed arrow represents a large rainfall event (41.1 mm in five days).

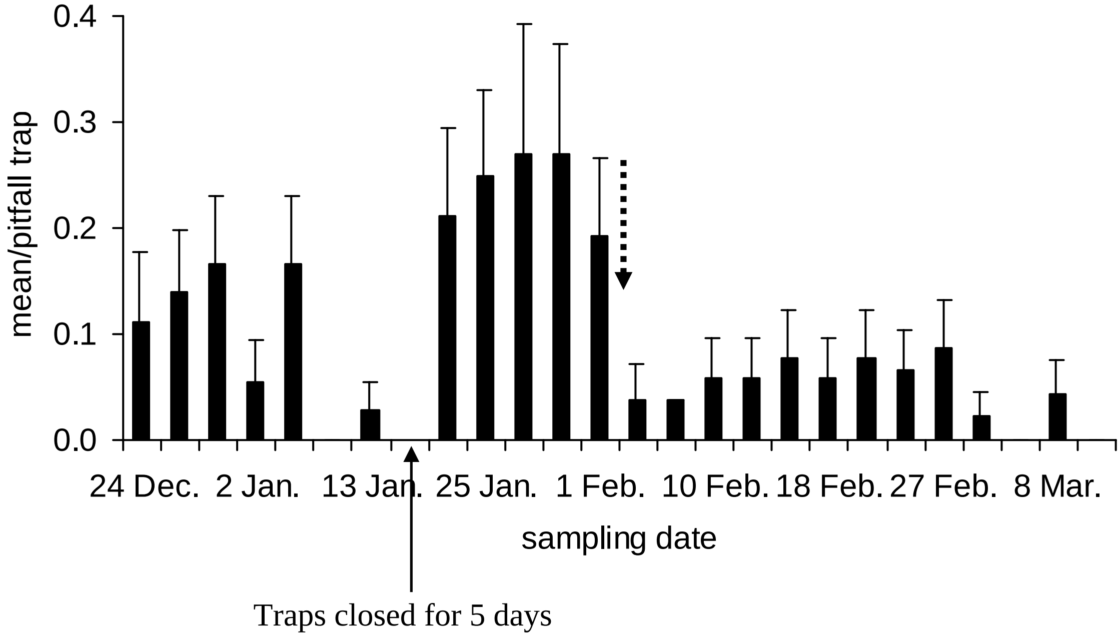


Figure 4. Seasonal pattern of Lycosidae activity in a soybean field Gilbert A (2001/02) as measured in pitfall traps. Bars indicate standard error. Dashed arrow represents large rainfall event (44.2mm in five days). Traps were closed for five days during grid sampling (Chapter eight).

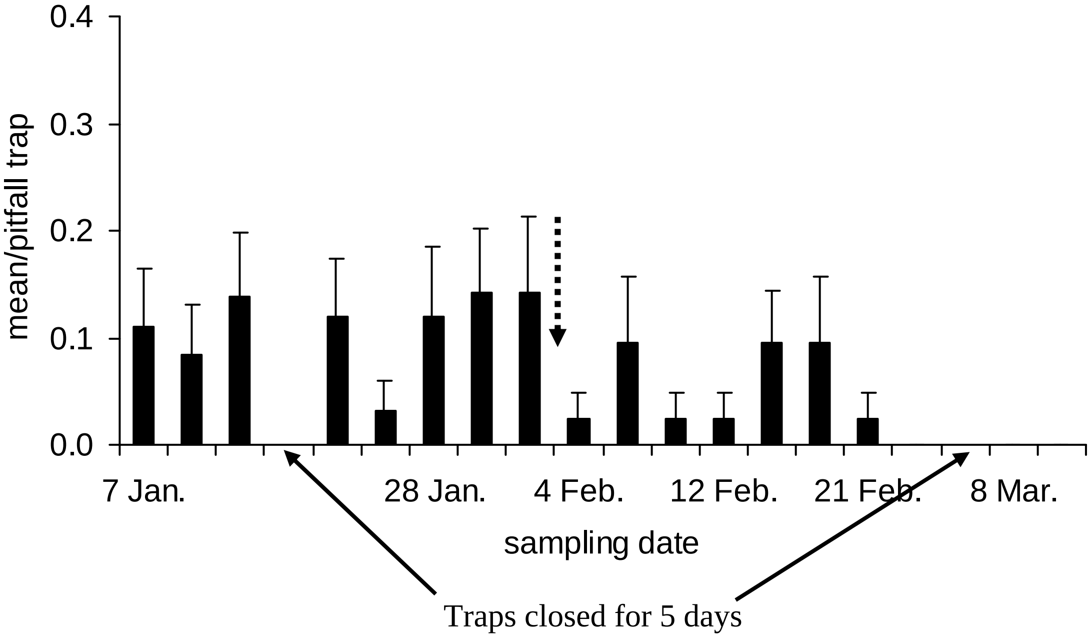
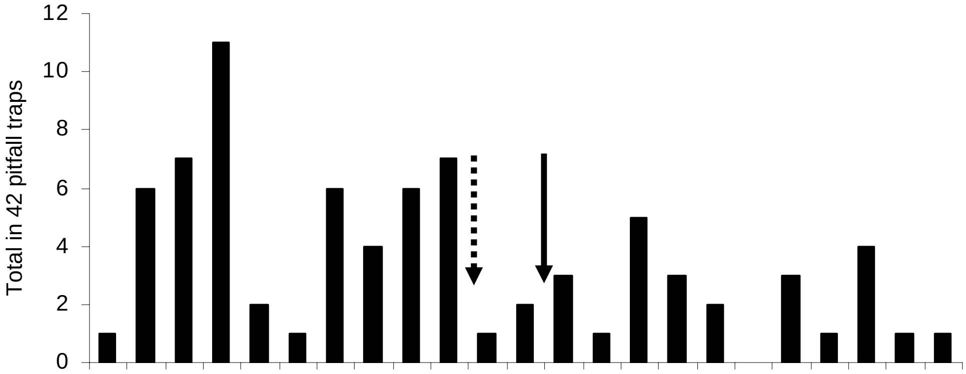
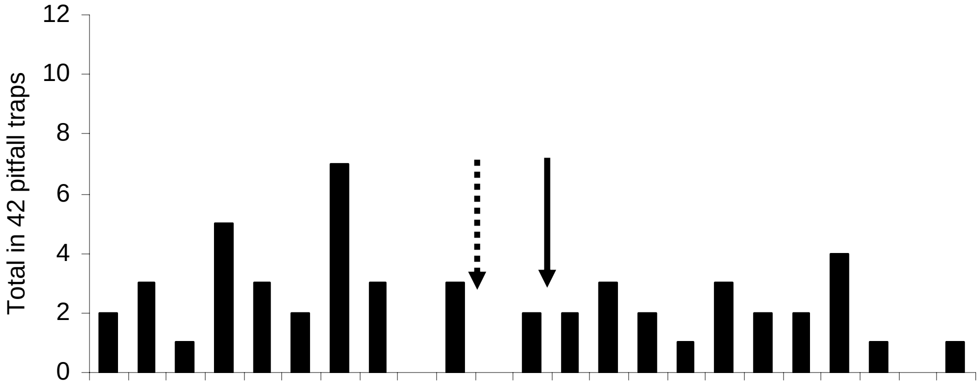


Figure 5. Seasonal pattern of Lycosidae activity in a soybean field Gilbert C (2001/02) as measured in pitfall traps. Bars indicate standard error. Dashed arrow represents large rainfall event (44.2mm in five days). Traps were closed for five days during grid sampling (Chapter eight).

A. Immature Lycosidae



B. Adult Female Lycosidae



C. Adult Male Lycosidae

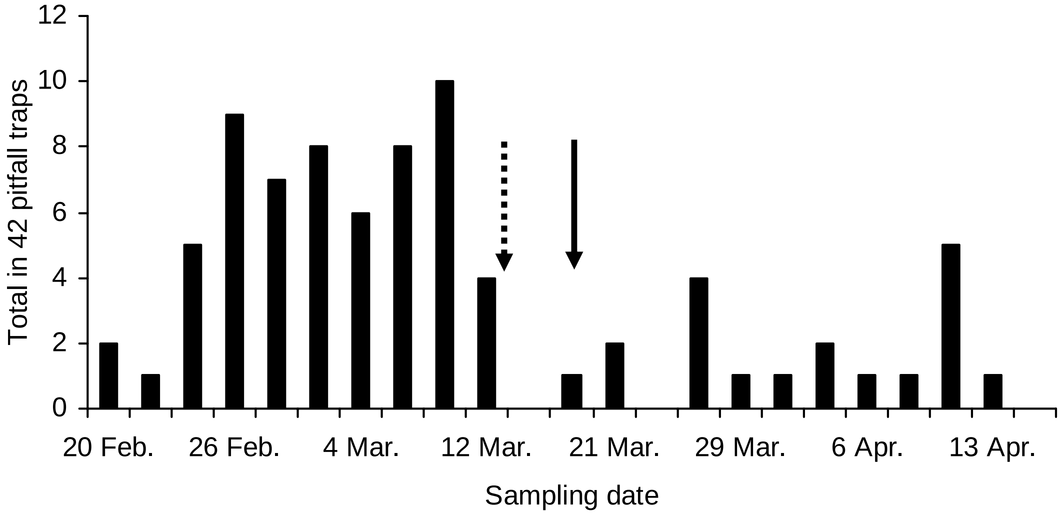


Figure 6. Seasonal pattern of **A.** immature and **B.**, **C.** adult Lycosidae activity in a soybean field Horti. (2000/01) as measured in pitfall traps. Solid arrow represents when an insecticide spray was put on some areas of the soybean field. The dashed arrow represents a large rainfall event (41.1 mm within five days).

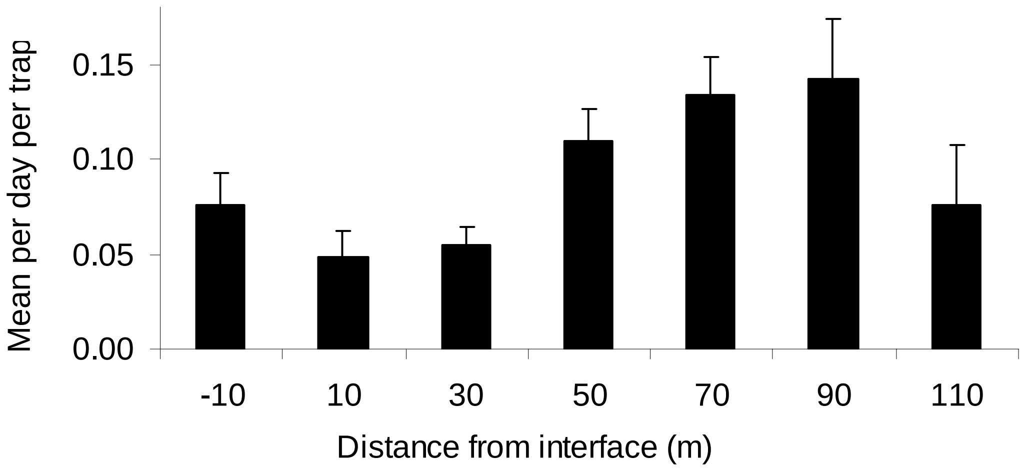


Figure 7. Lycosidae caught in pitfall traps in a soybean field Horti. at distances from lucerne across the whole season (2000/01). The –10m value represents 10m into the adjacent lucerne field and the final sampling distance (110m) is 40m away from the edge of the field. Bars indicate standard error.

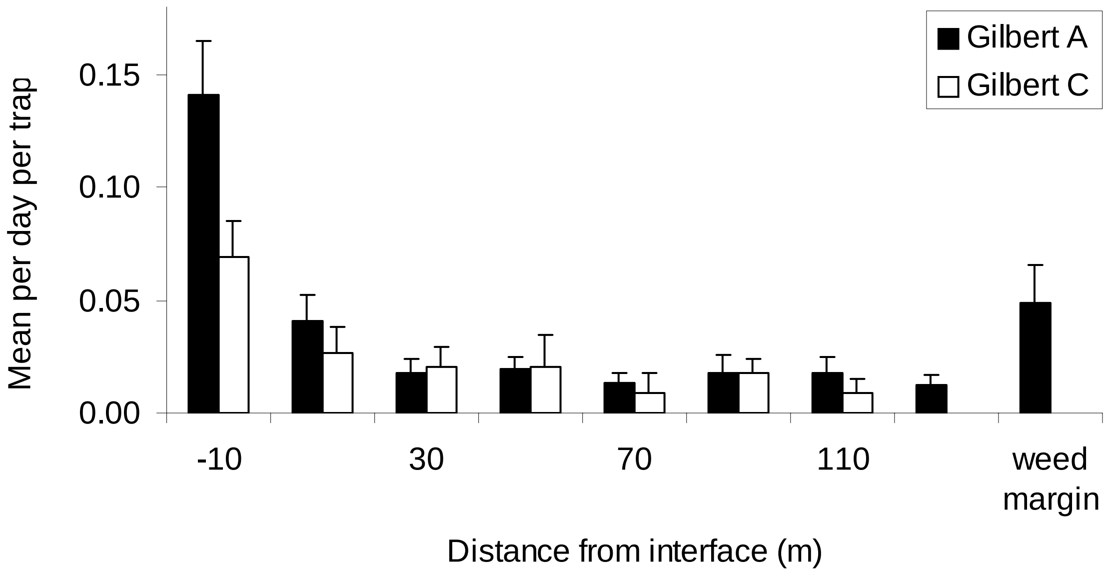


Figure 8. Lycosidae caught in pitfall traps in soybean fields Gilbert A and Gilbert C at distances from lucerne across the whole season (2001/02). The –10m value on the x-axis represents 10m into the adjacent lucerne field. Bars indicate standard error.

Discussion

Despite the low recapture rate during this experiment the few spiders recaptured provided a great deal of information. Lycosidae in this study are capable of travelling great distances, in excess of 65 metres. They can, and do cross the lucerne-soybean interface, even if the two crop types are not directly adjacent. Finally they will cross road areas with minimal amounts of vegetation cover. These results are supported by work on Lycosidae assemblages across woodland-pasture interfaces (Martin & Major 2001). This study found that edge effects were unimportant for Lycosidae. There was a clear difference in the Lycosidae assemblage across the interface, however this change was due to species abundance rather than species composition. Buddle and Rypstra (2003) found that *Pardosa milvina* Hentz activity was not driven by changes in habitat (soybean that was tilled, no-till or mulched with straw). In contrast another Lycosid, *Hogna helluo* (Walckenaer), emigrated from no-till soybean habitats more than mulched habitats.

The average straight-line distance travelled, 3.2 metres per day is higher than that found by other researchers (Hallander 1967, mean 0.1 to 0.3 metres per day; Dondale *et al.* 1970, 10.6 metres per day). This figure may be an artifact of the low recapture rate (0 to 4.5%). A more intensive sampling grid (say 84 traps rather than 42) may be necessary to obtain more animals for marking and a greater recapture rate. Kiss and Samu (2000) used 121 traps in a 20m by 20m area of alfalfa field, marked 2,191 lycosids and had a recapture rate of 5-19 percent. A greater recapture rate would assist in determining if there is directional movement of the marked lycosids away from the release point. No conclusions about the direction of movement can be drawn from only four recaptures.

Seasonal patterns in lycosid activity show that the peak reproductive period is at the beginning of the summer season. The seasonal pattern of immature activity displayed decreasing waves from the initial peak in the vegetative to flowering period of the crop. This is supported by a directional pitfall trap study (see Chapter three) that found greater pitfall trap catches of Lycosidae at the start of the season. There may be other population peaks throughout the winter months. Given the life span of the adult Lycosidae captured (greater than 90 days) this group of spiders may have one life cycle per year. Marshall *et al.* (2002) found that *P. milvina* had one population peak per year (in summer) and *H. helluo* may have two peaks per year in soybean agroecosystems. There was some evidence to suggest that *H. helluo* males may overwinter as adults or sub-adults and mature in the following spring. It would be interesting to determine if and how Lycosidae species used in this study survive the winter months when soybean is absent.

More males than females were caught in the traps throughout the season. This supports a previous study that suggested that female Lycosidae are less active when carrying egg sacs and spiderlings (Hallander 1967). A female with an egg sac was caught once in the pitfall traps and females carrying young were occasionally caught. Females carrying young were caught in ethanol filled pitfall traps during other experiments. It is difficult to determine if the lower catch rate of females in the pitfall traps was due to less activity or a lower abundance in the field. Topping and Sunderland (1992) found that generally males outnumbered females in pitfall trap catches of spiders in a wheat field. Direct sampling in the same wheat field showed that the ratio of males and females was one to one.

It was originally hypothesised that the traps within the lucerne field would capture the most Lycosidae, and there would be a decreasing trap catch into the soybean, away from the lucerne interface. It was assumed that Lycosidae would be most active within lucerne because of the undisturbed soil, relatively closed crop canopy and large numbers of easily accessible prey. This pattern was seen in Gilbert A and Gilbert C fields (supported by the results found in Chapter eight) but not in the Horti. field site, where traps at 50m to 90m away from the interface caught the most Lycosidae. This trend can partly be attributed to crop conditions. The soybean crop adjacent to the lucerne field was dominated by low growing, stunted plants, with high weed density between the rows. The plants located farthest away from the lucerne interface were generally healthier, and the ground between the rows had lower weed density. It appears that in this field the Lycosidae were most active in areas were the ground had low weed density between rows but the soybean canopy was tall enough to provided some shelter. Large rainfall events may result in decreased activity. Kiss and Samu (2000) also found lower pitfall trap catches of Lycosidae after rain. This may be due to the rain causing closure of soil cracks that are used often by Lycosidae for shelter (personal observation). Alternatively, the pitfall traps may have been less effective in capturing spiders after heavy rain. Heavy rain caused soil to wash into the traps, decreasing their depth and leaving mud on the sleeve, both of which may have enabled more spiders to escape from the traps. The single insecticide treatment in Horti field (fig. 3) appeared to have some effect on the activity of the Lycosidae (see Chapter six for further analysis). However, the overall trap catch was already beginning to decline prior to the insecticide spray. Testing the effects of environmental variables on Lycosidae activity was beyond the scope of this project. Further studies investigating the effects of different irrigation practices (flood or pivot irrigation) and weed density on Lycosidae abundance would provide some interesting results.

Significance for pest control

The Lycosidae have often been overlooked in pest control studies in Australia, which concentrate on the activities of predators within the crop canopy during the day. The nocturnal, ground-dwelling life style of Lycosidae does not mean they are unable to contribute to pest control. Their significance for pest control lies in the fact that they are active in exposed soil habitats such as that found early in the cropping season. The Lycosidae in this study were found to be most active during the first half of the season, before canopy closure had occurred. Many other predators do not migrate into the crop in great numbers until the plants are established (Stanley 1997, Johnson *et al.* 2000). Lycosidae are able to consume pest species early in the season when other predator numbers may be low. Lycosidae have been shown to prey on *Helicoverpa* spp. in cotton (Hayes & Lockley 1990), Cicadellidae and Thysanoptera populations in maize (Lang *et al.* 1999) and other Lepidopterous pests (Whitcomb & Bell 1964). *Helicoverpa* spp. eggs fall prey to actively searching Lycosidae (Nyffeler *et al.* 1990). In the laboratory Lycosidae will eat a variety of prey, including *Helicoverpa* spp. larvae (see preliminary experiment, this chapter and Chapter 10).

It is clear from these results that Lycosidae are capable of travelling between fields within the same area and between areas within a larger field. They are not restricted by vegetation changes such as one crop (soybean) to a different crop (lucerne), or a crop habitat to a weedy edge. This fact may pose problems for researchers using small plot trials in which each plot is considered an independent sampling unit. This is further support for the proposition that pest control (and predator augmentation) must be managed on an area-wide basis.

Chapter Summary

- A preliminary experiment was conducted to determine if a marking agent (dots of coloured correction fluid on the cephalothorax) affected spider life span, and behaviour.
- The control spiders had a longer life span (mean 75.3 days ± 4.58 standard error) than the marked spiders (53.4 days ± 10.46), however this difference was not significant (p-value = 0.16).
- The use of correction fluid appears to have little affect on the survival time of Lycosidae. It is considered a useful marking agent for adult Lycosidae because it will be retained for a long time, and can be applied easily in the field and is inexpensive.
- Within-field seasonal abundance patterns of adult Lyscosidae were investigated using regular collections of spiders. Marking and releasing the collected individuals allowed an assessment of the within-field movement of Lycosidae.
- The mark-recapture experiment showed that the average straight-line distance traveled by Lycosidae spiders within a soybean field 3.2 ± 0.82 metres per day.
- A very low recapture rate (from 0 to 4.5%) prevented any conclusions on the direction of movement away from the release point.
- Seasonal patterns in Lycosidae activity showed that the peak reproductive period is in the first half of the season, before canopy closure had occurred (also see Chapter three). Within a season, immature Lycosidae activity peaked in the vegetative to flowering period and then decreased in a wave-like pattern.
- Lycosidae may be very important for pest control early in the season when other predator numbers may be low.
- Lycosidae are capable of travelling between fields within the same area and between areas within a larger field. They do not appear to be restricted by vegetation changes such as one crop (soybean) to a different crop (lucerne) or a crop habitat to a weedy edge.

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