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Abundance and dynamics of wolf spiders (*Lycosidae*) in different plant communities

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Abstract. The aim of the present work was to investigate the abundance and seasonal dynamics of wolf spiders in different plant communities.

During the study, 529 individuals of wolf spiders were collected. A statistical analysis of the results indicated that, compared with clover, the number of wolf spiders was significantly lower on rape, wheat and fallow during the whole period of the experiment. It appeared that wolf spiders preferred habitats where plant cover was greater and older. In comparison with rape, the number of wolf spiders was significantly greater in the fallow variant. Both on rape and wheat the number of spiders was lower throughout the experiment, and a comparison of these variants showed no statistical significance. A comparison of wheat with fallow revealed no reliable differences in the number of spiders, although there existed a slight tendency in favour of fallow. On rape and wheat the number of spiders was lower during the whole experimental period, and a comparison of these variants with clover and fallow showed no statistical significance.

The seasonal occurrence of spiders in the rape and wheat variants was different in comparison with the clover and fallow plots. In spring the activity of wolf spiders was low in the rape and wheat variants. The activity of wolf spiders significantly depended on the pest spraying times in the experimental fields. After treatments with Fastac (in May and June) in the rape variant and with a herbicide (in June) in the wheat variant, the number of spiders started to increase, however, this was only a small population peak and decreased very quickly. In the rape and wheat variants, the seasonal dynamics of the spiders showed one population peak in July, regardless of the treatments applied in May and June. A large number of juveniles was caught in pitfall traps of all test variants during the midsummer time. In May the number of spiders was low in the clover and fallow variants but started to increase quickly at the beginning of June. The seasonal occurrence of spiders shows a smaller population peak in June (on clover and fallow) and a large peak in July (only on clover). The peak was lower but broader in the clover variant. After the population peak, the number of spiders decreased again, because hay was made in the clover and fallow variants at the beginning of July. Spiders left those variants in one week (clover variant), or by the end of the vegetation period (fallow variant).

Key words: *Araneae*, *Lycosidae*, wolf spider, pesticide, plant community

INTRODUCTION

Spiders are well-known predators but, compared with insects such as ground beetles, they have received relatively little attention as natural enemies of crop pests. Spider abundance is correlated with the specific vegetation characteristics, suggesting that the availability of habitats is important for spider colonisation and establishment (Rypstra & Carter, 1995). Increased weed coverage can result in higher numbers of epigeic spiders in the field (Frank & Nentwig, 1995), and can also lead to higher densities of spider assemblages inhabiting foliage. This suggests that there are interactions between the communities in canopy and the ground cover (Altieri & Scmidt, 1986; Wyss, 1995; Wyss et al., 1995).

A wide range of species can occur in arable fields, of which money spiders (Linyphiidae) and wolf spiders (Lycosidae) are the most abundant ones (Alford, 2003). Wolf spiders can easily be recognised by their adult females carrying a spherical egg sack behind and the subsequent transport of the young on their abdomen. Most wolf spiders are well camouflaged in their surroundings and are often seen hunting during daytime. They do not build webs for prey capture. Wolf spiders are typically epigaeic predators. They occur generally in Europe, especially on heliophil and xerophil sites, in agricultural areas (Nyffeler & Breene, 1992; Toth et al., 1996). Wolf spiders were reported as important predators of the cereal aphid, *Rhopalosiphum padi* (Nyffeler & Benz, 1982; Mansour & Heimbach, 1993). However, the major components in the spider's diet are springtails and dipterans (Nyffeler & Benz, 1988). Within oilseed rape crops, their prey includes larvae of the pollen beetle (*Meligethes aenus*) and the brassica pod midge (*Dasineura brassicae*) that have dropped to the ground prior to pupation. Food is often limited, but spiders have adapted to withstand the starvation periods (Sunderland et al., 1999). When food becomes available, spiders are able to gorge themselves (Sunderland et al., 1999). The two major factors influencing the development of ground-dwelling lycosid spider communities could be the effect of pesticide treatments and weed cover. An additional factor could be the boundary effect, and in arable ecosystems these pesticide-free areas can conserve spider populations and thus represent an important source of immigration (Alderweireldt, 1989; Kromp & Steinberger, 1992; Toth et al., 1996).

The aim of the present work was to investigate the abundance and seasonal dynamics of wolf spiders in different plant communities.

MATERIALS AND METHODS

Observations were carried out in the experimental field of the Estonian Agricultural University in the summer of 2003. The experiment included four variants: intensive rape (fertilizer + Fastac), wheat (fertilizer + herbicide), clover, and fallow. In spring the plots of rape and wheat were mechanically cultivated two or three times and treated with the herbicide Trifluralin and fertilised with Opti Crop 21-8-12+S+Mg+B before seedling. For pest control Fastac was used twice (28 May and 26 June) in the rape variant, and the wheat variant plants were treated with an herbicide once (10 June). During the observation period, hay was made once (in July) on the clover and fallow plots. Spiders were caught with pitfall traps. Each variant had three replications. During the observation period, spiders in the traps were counted once every week in all test variants.

Data are presented as mean ± standard error. The statistical comparison was performed by means of ANOVA and Student's *t*-test. All means were considered significantly different at the $P = 0.05$ level.

RESULTS

During the study, 529 individuals of wolf spiders were collected. A statistical analysis (ANOVA) of the results indicated that, compared with clover, the number of wolf spiders was significantly lower on rape ($t = 11.92$, $P = 0.006$), wheat ($t = 21.11$, $P = 0.002$) and fallow ($t = 31.0$, $P = 0.001$) (Fig. 1) during the whole period of the experiment. In comparison with rape, the number of wolf spiders was significantly larger in the fallow ($t = -5.11$, $P = 0.03$) variant. It appeared that wolf spiders preferred habitats where plant cover was greater and older. A comparison of wheat with fallow revealed no significant differences in the number of spiders, although there existed a slight tendency in favour of fallow. Both on rape and wheat the number of spiders was lower during the whole experimental period, and a comparison of these variants showed no significant differences.

In May the number of spiders was low in clover and fallow variants but started to increase quickly at the beginning of June. The seasonal occurrence of spiders shows a smaller population peak in June (on clover and fallow) and a large peak in July (only on clover) (Fig.2). In June the population peak was lower but broader in the clover variant. After this peak, the number of spiders decreased again, because at the beginning of July hay was made in the clover and fallow variants. Spiders left those variants in one week (clover variant) or by the end of the vegetation period (fallow variant).

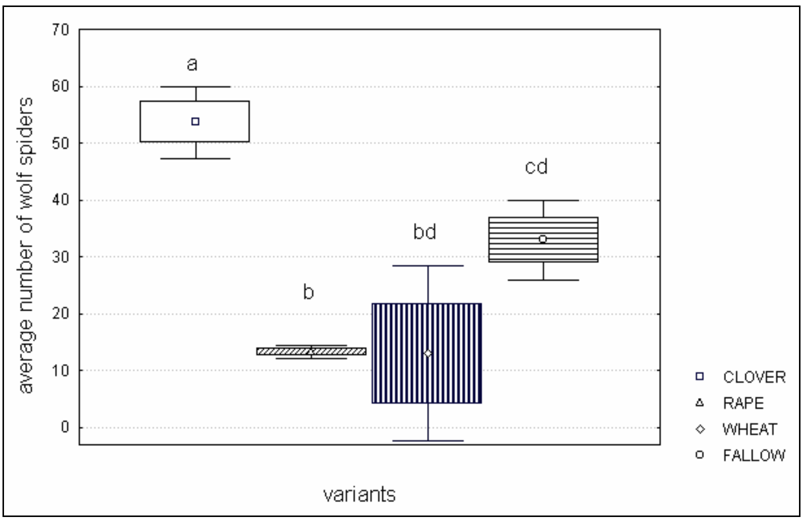

Fig. 1. Average number of wolf spiders in pitfall traps in different fields in 2003. Means followed by the same letter are not significantly different ($P < 0.05$).

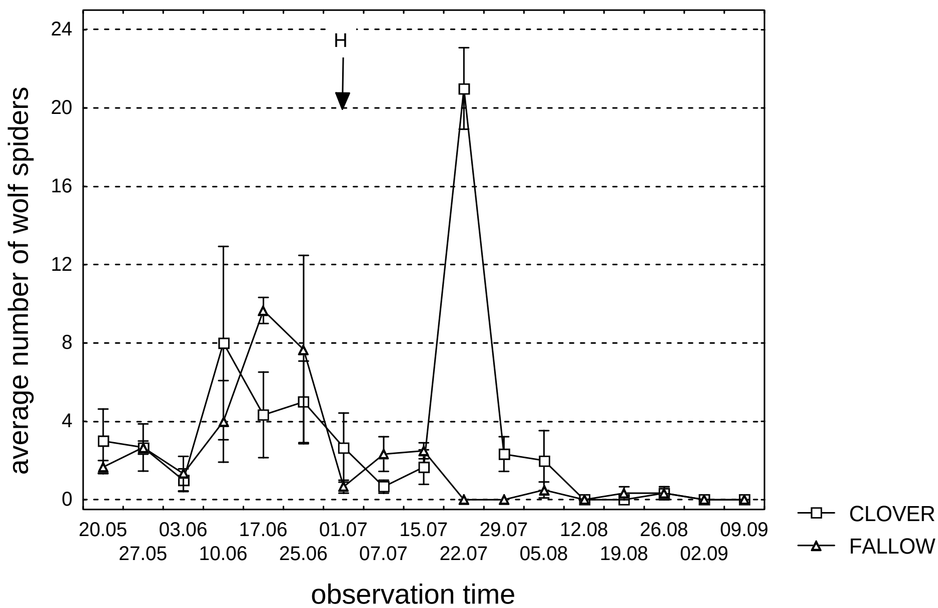

Fig. 2. Dynamics of wolf spiders in the clover and fallow variants during the observation period in the year 2003. (means ± SE) H- cutting time on clover and fallow.

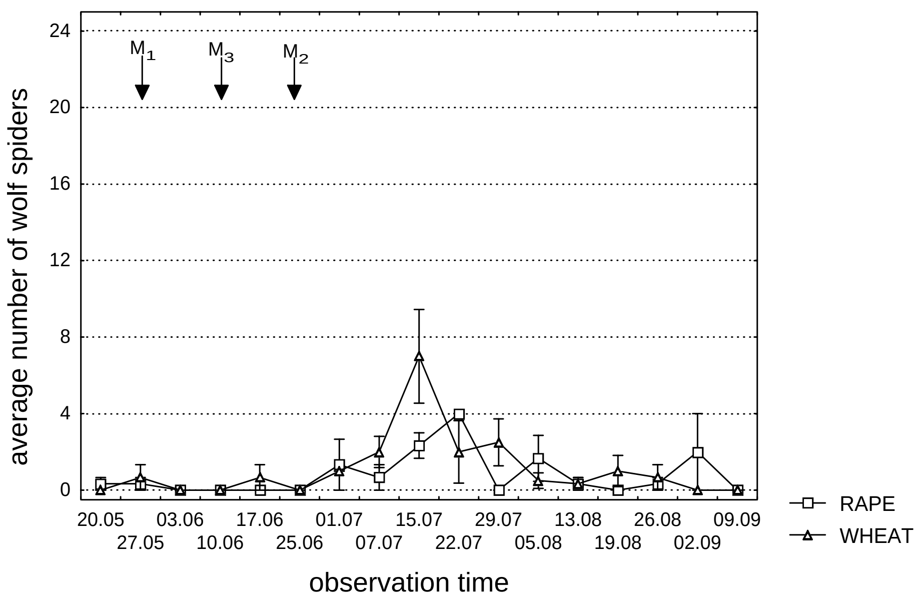

Fig. 3. Seasonal dynamics of wolf spiders in the rape and wheat variants during the observation period in the year 2003. (means ± SE) M_1; M_2 – spraying times with Fastac (on rape), M_3. – spraying time with herbicide(on wheat).

A large number of juveniles were caught by pitfall traps in all test variants at the midsummer time.

The seasonal occurrence of spiders in the rape and wheat variants was different in comparison with plots mentioned above. In spring the activity of wolf spiders was low in the rape and wheat variants (Fig. 3). The activity of wolf spiders significantly depended on the pest spraying times in the experimental fields. After treatments with Fastac (in May and June) in the rape variant and with a herbicide (in June) in the wheat variant, the number of spiders started to increase, however, this was only a small population peak and decreased very quickly. In the rape and wheat variants, the seasonal dynamics of spiders showed one population peak in July, regardless of the treatments in May and June.

DISCUSSION

Pitfall trapping as a sampling method has been criticised in ecological studies, because the catch can be influenced by factors other than abundance (Topping & Sunderland, 1992). Problems include different trappability of species, different activity patterns, variable capture rates of males and females, and effects of habitat structure. Nevertheless, pitfall trapping is extensively used to study ground-dwelling arthropods (including spiders) because pitfall traps are inexpensive, easily monitored and trap a large number of a wide range of species. Sampling is continuous and therefore not prone to problems connected with the time of spot sampling. Additionally, the results of pitfall trapping often show strong correlation at community level with those desired from other observations.

This study indicated significant differences between wolf spiders in different plant communities. Wolf spiders are active wanderers at ground level and, therefore, a large number of spiders was caught by pitfall traps. In the clover and fallow variants, where no pesticide applications were used, significantly more wolf spiders were found. This agrees with laboratory studies of the effect of pesticide residues on the wolf spider, *Paradosa agrestis* (Mansour et al., 1992). Additionally, research work by Bogya and Marko (1999) show that *P. agrestis* preferred habitats where weed density was higher. Weed density is a general phenomenon connected with spiders and mentioned in many studies (Frank & Nentwig, 1995). However, some species entirely prefer microhabitats with low weed covers (Alderweireldt, 1989). In our work the abundance of wolf spider assemblages could be enhanced by increasing the ground cover density in different plant communities. Greater numbers of spiders were observed within the clover, where the plant density was higher, than on other experimental plots. One reason why the number of wolf spiders was the lowest on the rape plot was probably the sparse plant cover in this variant.

Experiments conducted in the USA with weed strips of alfalfa fields sown at the edge contained a high density of spiders, however, the spiders did not walk out into the crop. The authors suspected that the weed borders were so hospitable to spiders that they had no stimulus to disperse (Bugg et al., 1987). Probably the same fact had an effect on the rape and wheat plots of our experiment, because wolf spiders did not move from clover to the variants mentioned above, although the variants were situated side by side. Another possible explanation for the highest number of wolf spiders on clover is that many phytophagous pests and spiders had found good prey and habitat conditions there. In the fallow variant, wolf spiders had partly similar conditions to arthropods prey, but there were less phytophagous pests. Spiders had a good habitation place there, but not enough different food. The spider density can actually be augmented by increasing the density of their fungivorous and detritivorous prey; this phenomenon was studied in a forest floor system (Chen & Wise, 1999), and may also apply to crop systems.

Intensively cultivated arable fields are not self-contained systems for invertebrate predators as their life cycles are interrupted periodically by severe agricultural practices such as ploughing, sowing, spraying, etc. Intensively managed fields, where synthetic, broad-spectrum insecticide use is high year after year, have spider faunas of low density and diversity (Miliczky et al., 2000). This agrees with our work: in the rape and wheat variants the life cycles of wolf spiders were periodically interrupted. Spiders immigration to intensively cultivated areas may be limited, because most of the surrounding land is also insecticide-treated. The number of wolf spiders was the lowest on the rape plot as in this variant Fastac was used for pest control twice. On the rape and wheat field plots the soil was cultivated, and fertilisers, herbicides and pesticides were used. Chemicals used and cultivation may be the reasons for the lower number of spiders in the rape and wheat variants. Topping and Sunderland (1998) showed similar effects of ploughing and harvesting on the numbers of spiders in cereal fields.

Spiders can overwinter at the edges of fields (Maelfait & De Keer, 1990) and there is some potential for improving these habitats for spiders by vegetational diversification to include grass tussocks (Bayram & Luff, 1993) and wild flowers (Harwood et al., 1994; Thomas & Marshall, 1999), and by reducing the intensity of management practices (Feber et al., 1995). On our experimental plots, conditions for the habitation and overwintering of spiders were probably better in the clover and fallow than in intensively cultivated variants. Clover and fallow had been growing in same place also a year before and wolf spiders had good opportunities for overwintering there. The number of wolf spiders tended to be greater at the edge than in the middle of the fields. Rape and wheat plots were located in the middle of a big cereal field, which might have had an influence on the abundance of wolf spiders. In addition, the field part where rape and wheat were sown this year was used before for growing other intensively managed cultures.

The seasonal occurrence of spiders shows that wolf spiders are very sensitive when different chemicals, in addition to other agricultural practices, were used on the experimental plots. The activity of wolf spiders was low in the rape and wheat variants in spring, it seems that the activity of spiders significantly depended on the pest spraying times in the experimental field and the intensive management of those plots. After rape and wheat treatments with chemicals, the number of spiders started to increase, however, these were only small population peaks and decreased very quickly. A probable reason for the small population peak in both variants was the appearance of a new generation – because a high number of juveniles were found in pitfall traps at this time of observation. The seasonal occurrence of spiders in the clover and fallow variants was different in comparison with rape and wheat. In May the number of spiders was low in both variants but started to increase quickly at the beginning of June as the plants had fully grown by that time. The plant cover affected favourably the dynamics of the spider population, particularly from late spring until summer. After the population peak, the number of spiders decreased again, because hay was made in the clover and fallow variants at the beginning of July. The cutting probably influenced the abundance of spiders on those plots negatively. Cutting had an immediate effect on the number of wolf spiders in the clover and fallow variants. The prey conditions for wolf spiders changed on the experimental plots, and they left those variants in one week (clover variant), or by the end of the vegetation period (fallow variant). The reason why spiders did not return to the clover and fallow plots at same time were differences in the growth speed of clover and fallow.

CONCLUSIONS

The activity of wolf spiders significantly depended on the intensity of field management practices, including pest spraying times. The increase of ground cover density in plant communities could enhance the abundance of wolf spider assemblages. Spiders preferred the clover and fallow variants, where the soil was uncultivated and no fertilisers, herbicides and pesticides were used.

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