Intensity of area searching in grasslands and grassland borders by some dominant spider species

Anna Kajak

Institute of Ecology, Polish Academy of Sciences
05-092 Łomianki, Dziekanow Lesny. Pologne.

Introduction

Some papers published in recent years (Chiverton, 1986 ; Nyffeler and Benz, 1987 ; Reichert and Bishop, in press) show that polyphagous arthropods are an important factor of crop pests control. Consequently, increasing emphasis is put to landscape studies analysing numbers of these predators and, even more frequently, their area searching in different ecosystems (Gravesen and Toft, 1987 ; Krause, 1987 ; Nentwig, 1988 ; Kajak, in press). Also ecotones receive much attention, in particular the crop field margines which are considered as areas from which predators can immigrate.

My paper compares the intensity of area searching on grasslands and their immediate surroundings crop fields and forest islands, by spiders, the most abundant group of epigeic, polyphagous predators in this area. Grasslands are very similar to crop fields in terms of the species composition and structure of the spider communities (Kajak, in press). The study based on recaptures of marked individuals (Kajak, in press) and habitat manipulation (Gravesen and Toft, 1987) revealed an exchange of individuals between grasslands and crop fields. Thus, a question arises if the bordering strip between these ecosystems has a distinct character? In which respect grassland-crop field borders differ from grassland-forest borders?

Study area and methods

The frequency of area searching by the group of migrants was analysed by pitfall traps. Traps were checked every two days. The main sampling period coincided with the most intense area searching by predators, which occurred in May and June. Samples were taken in 1987-1989. Traps were set along two perpendicular lines : ten traps along the border line between grassland and the adjacent ecosystem, always on the grassland side, and ten traps on the perpendicular line in each of the adjacent ecosystems. The distance between successive traps was 2 m, thus the line of traps went 20 m deep into each of the two bordering ecosystems. A total of seven border lines were analysed, four grassland-crop field borders, and three grassland-forest island borders.

The study was carried out in north-eastern Poland, in a diversified landscape with post glacial rolling hills covered mostly with crop fields, meadows and pastures. Short -term grasslands (leys) were cultivated, interspersed with crop fields, and formed a part of the rotation system.

Permanent grasslands were located on stony soils or areas too steep for cultivation. They were floristically much more diversified than leys. All the study grasslands were of the class *Molinio-Arrhenatheretalia*. Short term meadows were dominated by *Dactylis glomerata*. Permanent grasslands, when extensively utilized, were covered by *Anthillidi trifolietum montani* association.

Results

Intensity of area searching

No significant differences were observed in the frequency of searching by spiders in particular grasslands, independently on the way of their cultivation or the kind of surroundings. Crop fields and forest islands however, were searched significantly less frequently than grasslands. Woodlots were visited even less frequently than crop fields (Tab. 1).

Table 1
Intensity of area searching

Total number of ind./pitfall trap × 2 days (May, June)

Grasslands among crop fields		Border line	Fields
Leys	13.96 ± 1.40 ↗	25.66 ± 1.97 ↘	5.35 ± 0.44
Permanent grasslands	15.84 ± 0.95 ↔	16.67 ± 0.78 ↘	8.51 ± 0.84
Grasslands bordering on forest			
Permanent grasslands	11.55 ± 0.76 ↘	6.93 ± 0.61 ↘	4.41 ± 0.45

L-PG n.s.
L-BL $p < 0.001$ F-L $p < 0.001$
PG-BL n.s. F-PG $p < 0.001$
PG-BL $p < 0.001$ F_0-PG $p < 0.001$

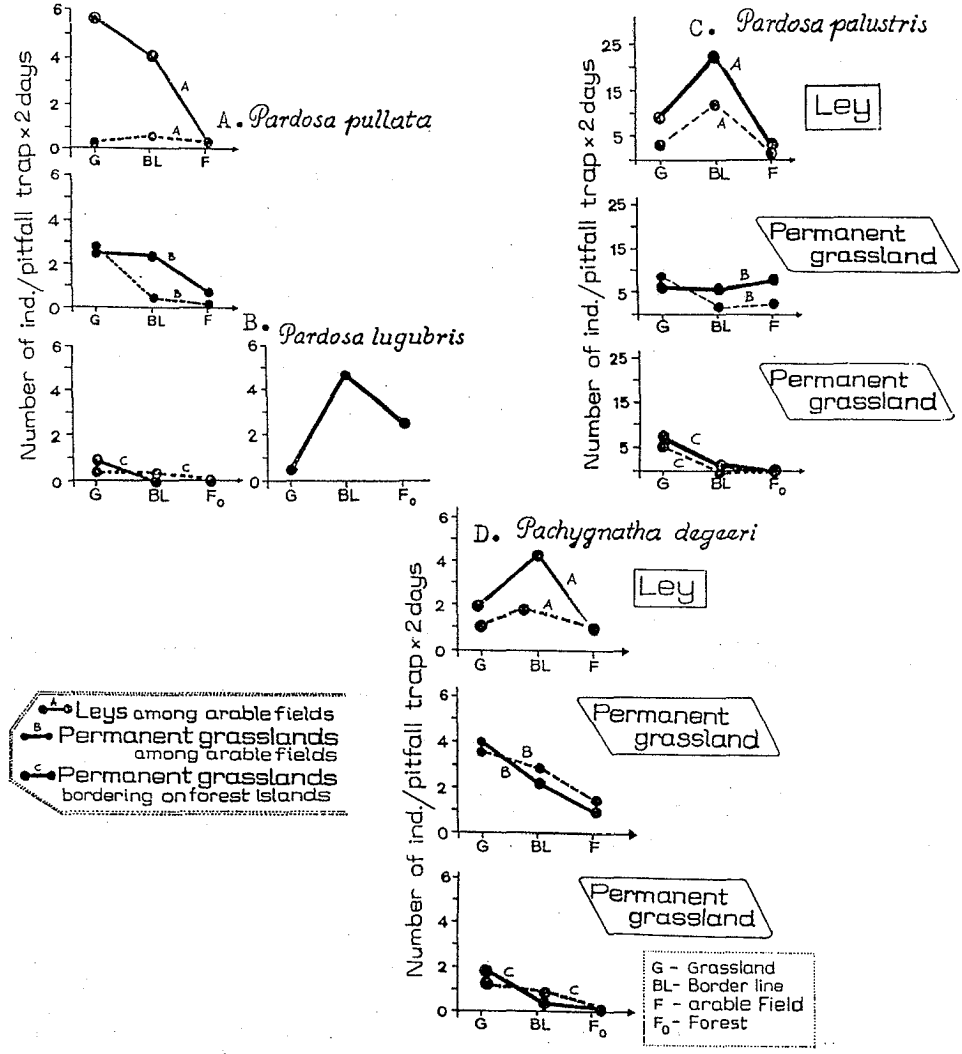
In the period of most intense area searching, all grassslands and crop fields were dominated by *Pardosa palustris*. This species accounted for 23 to 68% of the total number of the migrants caught on meadows, and 38-71% on crop fields. On grasslands and crop fields four species formed the bulk of the community : *Pardosa palustris, Pardosa pullata, Pardosa prativaga* and *Pachygnatha degeeri*. These four species comprised 82-94% of all individuals captured on meadows, and for 63-92% on the adjacent crop fields. On meadows adjacent to the forest islands, the proportion of the dominant species was of a similar order, 74 to 82%, but one of the dominant species, *Pardosa lugubris*, did not occur on meadows in cropland.

Borders between habitats

In some cases, the intensity of area searching by spiders in the marginal parts of the meadow differed from searching of other parts of the meadow. Ley-crop field border was significantly more frequently searched than either of adjacent habitats (t-test). A different situation was noted at permanent grassland-crop field borders, where no significant difference was found in area searching between the ecotone and the meadow. Still different situation was observed at grassland-forest island ecotones. These borders were searched by spiders significantly less than grasslands (Tab. 1). Figures in this table represent mean values for 2-3 sites with similar tendencies. Differences in the area searching between the ecotones and the inner parts of the meadow were mostly due to two dominant species, *Pardosa palustris* and *Pachygnatha degeeri*. Both these species visited the ley-crop

field borders more frequently than either neighbouring ecosystem. However they did not occur in the forest island and they visited less frequently the meadow-forest border than the inner parts of the meadow, or they even did not occur at the ecotone at all (Figs 1 C, D).

Figure 1
Intensity of area searching



Pardosa lugubris showed an opposite tendency, that is an increased exploration of the meadow-forest island ecotone (Fig. 1B).

Also the number of species was typically higher at the ecotone than in the adjacent habitats. This was found at most of the ecotones (5 out of 6). But the Shannon-Wiener diversity index did not show this tendency. Community diversity was significantly higher at the ecotone than on the grassland only in one out of six cases, and this was the grassland-forest ecotone (Tab. 2).

Table 2
Shannon-Wiener diversity index

Grasslands among arable fields

Ley	Grassland	B_oL	Field	G-B_oL
N. of species	22	18	15	
H'	1.31 ± 0.09	0.88±0.11	1.95±0.06	n.s.
E	0.42	0.30	0.72	
N. of species	17	20	16	
H'	1.69 ± 0.07	1.61±0.07	1.71±0.06	n.s.
E	0.60	0.54	0.62	
Permanent grasslands				
N. of species	18	20	14	
H'	1.50±0.06	1.71±0.07	1.02±0.11	n.s.
E	0.52	0.57	0.39	
N. of species	17	19	12	
H'	1.37±0.07	2.04±0.07	1.88±0.08	n.s
E	0.48	0.69	0.76	

Grasslands bordering on Forest Islands

Permanent grassland

1	Grassland	B_oL	Forest	G-B_oL
N. of species	22	27	17	
H'	1.88 ± 0.08	1.20±0.12	1.27±0.15	n.s.
E	0.61	0.36	0.45	
2				
N. of species	24	25	21	
H'	1.35 ± 0.09	2.18±0.08	2.32±0.08	p<0.05
E	0.42	0.68	0.76	

Moreover, the proportion of egg sac carrying females in the total number of females of the dominant species was higher at the ecotones (Tab. 3).

Table 3
Proportion of egg carrying females %

	Egg carrying females • Total number of females			
	Ley	B_oL	Permanent grassland	B_oL
1	14.3	17.9	33.3	66.7
2	8.0	12.9	17.4	42.8

$Chi^2 = 13.7 \quad p < 0.01 \quad df = 3$

At the ley margins, which were more intensely visited, also the proportion of all females in the total number of individuals was significantly higher (Tab. 4).

Table 4
Proportion of females in populations of dominant species

% females in total number of ind. captured	Site	Ley	B_oL
	1	8.4	15.7
	2	15.1	25.4

$B_oL > L$ – Wilcoxon matched pairs signed-ranks test T=0, N=6, P=0.05

Thus border lines can be explored with a different intensity than the remaining parts of the grassland, they support a spider community richer in species and with higher proportions of egg carrying females and in some plots also with a higher proportion of all females in the population. These patterns were recorded in the periods of maximum trappability but not in the other periods of the growing season.

A question arises of the width of this marginal zone. The comparison of area searching by *P. palustris* and *P. degeeri* on leys in successive 4-m-wide sections increasingly distant from the ecotone has shown that only the border line, that is, no more than a 2-m-wide strip, was significantly different. At the meadow-forest border, the zone different from other parts of the meadow was wider.

Pardosa lugubris, the species abundantly occurring in this zone, gradually declined with the distance from the forest line, and disappeared 12 m from it (Tab. 5). *Pardosa palustris* showed an opposite trend. Its abundance increased with the distance from the forest island.

It may thus be concluded that ecotone effect is variable. Under some conditions and for certain species it is clearly cut (e.g. ley-crop field border), whereas under other conditions and for other species it is weak (permanent grassland-crop field border). Also the ecotone width is variable. For *Pardosa lugubris* and *P. palustris* the grassland-woodlot ecotone is 12 m wide. For *P. palustris* the grassland-crop field ecotone typically does not exceed 2 m.

Table 5
Spatial pattern of area searching on grassland-forest border

	B_oL	Grassland				
Distance from border line /m/	0	0–4	4–8	8–12	12–16	16–20
Number of ind. per pitfall trap • 2 days						
Pardosa lugubris	23.50	5.50	1.00	4.50	0.0	0.0
Pardosa palustris	0.72	2.80	5.80	5.60	9.56	9.11

Kendall rank correlation coefficient in grassland

Pardosa palustris $\tau = 0.738$, $0{,}117 > p > 0.042$

Pardosa lugubris $\tau = -0.843$, $p = 0.042$

The increased area searching at ecotones as compared with more distant parts of the adjacent habitats occurs only in species abundant on either side of the border line.

References

Chiverton, P.A. 1986 - Predator density manipulation and its effect on populations of *Rhopalosiphum padi* (Hom. : Aphididae) in spring barley. - *Ann. appl. Biol.*, **109** : 49-60.

Gravesen, E. and Toft, S. 1987 - Grass fields as reservoirs for polyphagous predators (Arthropoda) of aphids (Homopt. Aphididae). - *J. Appl. Ent.*, **104** : 461-473.

Kajak, A. in press - Spatial pattern of the intensity of area searching by predators (Arthropoda). - *Ann. Zool. Fennici.*

Krause, A. 1987 - Untersungen zur rolle von Spinnen in agrarbiotopen. - *Dissertation, Univ. Bonn*, 306 pp.

Nentwig, W. 1988 - Augmentation of beneficial arthropods by strip-management. 1. Succession of predacious arthropods and long term change in the ratio of phytophagous to predacious arthropods in a meadow. - *Oecologia*, **76** : 597-606.

Nyffeler, M. and Benz, G. 1987 - Spiders in natural pest control. A. review. - *J. Appl. Ent.*, **103** : 321-339.

Reichert, S.E. and Bishop, L. in press - Generalist predator assemblage control of prey : spiders in a garden test system. - *Ecology*.