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Ecotone zones between forest islands and crop fields in the Masurian Lakeland, Poland, as barriers for migration of spiders to crop fields

par
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1. INTRODUCTION

The preliminary paper on forest islands in the agricultural landscape of Masuria (LUCZAK 1990) characterizes numbers, biomass, and age structure of spider communities. In the study of spiders living in the ecotones of forest islands (LUCZAK 1991), no spieces living exlusively in ecotones were found in the herb layer of forest islands, populations of many species occurred in forest ecotones and interiors throughout the growing season. There were differences in the dominant species between interiors and ecotones, also in their seasonal dynamics. The species showing preference either for ecotones or for interior of forest islands are listed.

The main purpose of the current work on forest islands is the analysis of relationships between the species of forest islands and the species of surrounding crop fields, separated by the zone of junction formed by the forest edge, structurally different from the forest interior with respect to the vegetation and microclimate (WOJCIK in print; Dabrowska-Prot, Luczak in print).

2. METHODS

In the present report the following "**variables**" are analysed in the herbaceous layer of six forest islands:

1. The number of species in forest islands, their ecotones and in the surrounding crop fields, their abundance, biomass and mean body weight.
2. Relative abundance of dominant species in the interior of forest islands, in ecotones, and in crop fields.

3. Percentage contribution of these groups of species to the total number of spiders in interiors and ecotones of the islands.
4. Abundance of species common to the interior and ecotone of forest islands, and to the ecotone and the surrounding crop field.

3. RESULTS

3.1 Concerning "Variable 1"

The six forest islands were inhabited by 35-49 species in inner parts and by 38-58 species in peripheral parts (forest ecotones). The surrounding crop fields were inhabited by only 16-30 species. Comparable samples collected with a sweep net and a quadrat frame contained more spiders from interiors of forest islands than from their ecotones, thus no edge effect was found for the whole group. The number of spiders collected in crop fields accounted for only 4%, 5.8%, and 6.8% of their numbers in ecotones. Similar proportions were found for the biomass of spiders. It should be noted, however, that epigean spiders are much more abundant in crop fields, and they are more important to this ecosystem (NYFFELER 1982).

Wood-lots dispersed in cropland can enrich crop fields with spiders (LUCZAK 1986; KRAUSE 1987), but in the landscape under study most species and individuals were retained within forest islands. Ecotones functioned as barriers to the dispersal of spiders into crop fields.

Mean body weight of spiders was higher in ecotones and interiors of forest islands than in crop fields, the last habitat being inhabited by smaller species and young forms. In 1989, the mean body weight of spiders was highest in ecotones (Tables I and II).

	Island n° 4			Island n° 5			Island n° 8		
	Inner part	Ecotone	Field	Inner part	Ecotone	Field	Inner part	Ecotone	Field
Number of species	49	58	29	45	49	16	48	52	30
General abundance (individuals)	1237	739	92	1423	646	87	1057	1180	112
%	60	35	5	66	30	4	45	50	5
Biomass mg w.w.	9739	6612	297	13686	6516	165	9583	14010	438
%	58	40	2	67	32	1	40	58	2
Mean weight of individual mg w.w.	7.87	8.95	3.23	9.62	10.10	1.90	9.07	11.87	3.91

Tab. I - Number of spiders, relatives abundance of spiders and their biomass /in mg w.w./ and weight of mean /statistical/ individual /in mg w.w./ .- on Pino-Quercetum island /n° 4/ and on two birch-aspen islands /n^{os} 5 and 8/ in their inner parts and marginal parts /ecotones/ and on neighbouring arable field. From 7 samples in the growing season 1989.

	Island n° 4			Island n° 6			Island n° 7		
	Inner part	Ecotone	Field	Inner part	Ecotone	Field	Inner part	Ecotone	Field
Number of species	44	56	21	35	38	21	40	48	27
General abundance (individuals)	1173	1199	46	1522	978	88	1586	1354	109
%	48	50	2	59	38	3	52	44	4
Biomass mg w.w.	7607	6454	204	11735	8501	358	10936	9248	369
%	53	45	2	57	41	2	53	45	2
Mean weigt of individual mg w.w.	6.48	5.38	4.43	7.71	8.69	4.07	6.89	6.83	3.38

Tab. II - Number of spiders, relative abundance of spiders and their biomass /in mg w.w./ and weight of mean /statistical/ individual /in mg w.w./ .- on Pino-Quercetum island /n° 4/ and on two birch-aspen islands /n^{os} 6 and 7/ in their inner parts and marginal parts /ecotones/ and on neighbouring arable field. From 7 samples in the growing season 1989.

3.2 Concerning "Variable 2"

The species living in inner parts of forest islands in the Masurian Lakeland consisted of *Meta segmentata, Linyphia triangularis, Linyphia montana, Gongylidium rufipes, Bolyphantes alticeps,* and *Helophora insignis* (Table III). All of them were abundant or rather abundant. The first two were the main dominants. The species of the forest

	Pino-Quercetum				Birch-aspen								M		
Forest islands	4		4		5		6		7		8				
Species	I	E	I	E	I	E	I	E	I	E	I	E	I	E	Total
Meta Segmentata	246	75	123	52	122	44	141	26	112	68	95	108	839	373	1212
Linyphia triangularis	216	120	250	130	251	36	125	41	204	111	165	165	1212	603	1815
Linyphia montana	14	16	18	7	38	5	93	9	117	94	61	28	341	159	500
Gongylidium rufipes	186	160	194	47	226	49	201	21	363	180	98	57	1268	514	1782
Bolyphantes alticeps	26	4	9	3	3	1	62	10	43	33	24	6	167	57	224
Helophora insignis	16		16		110		73		26		3		244	0	244

Table III. Relative abundance of species preferring innner part of forest islands. I - inner part E - ecotone

island interiors belonged to two families, Metidae- one species, and Linyphiidae s.l. - five species.

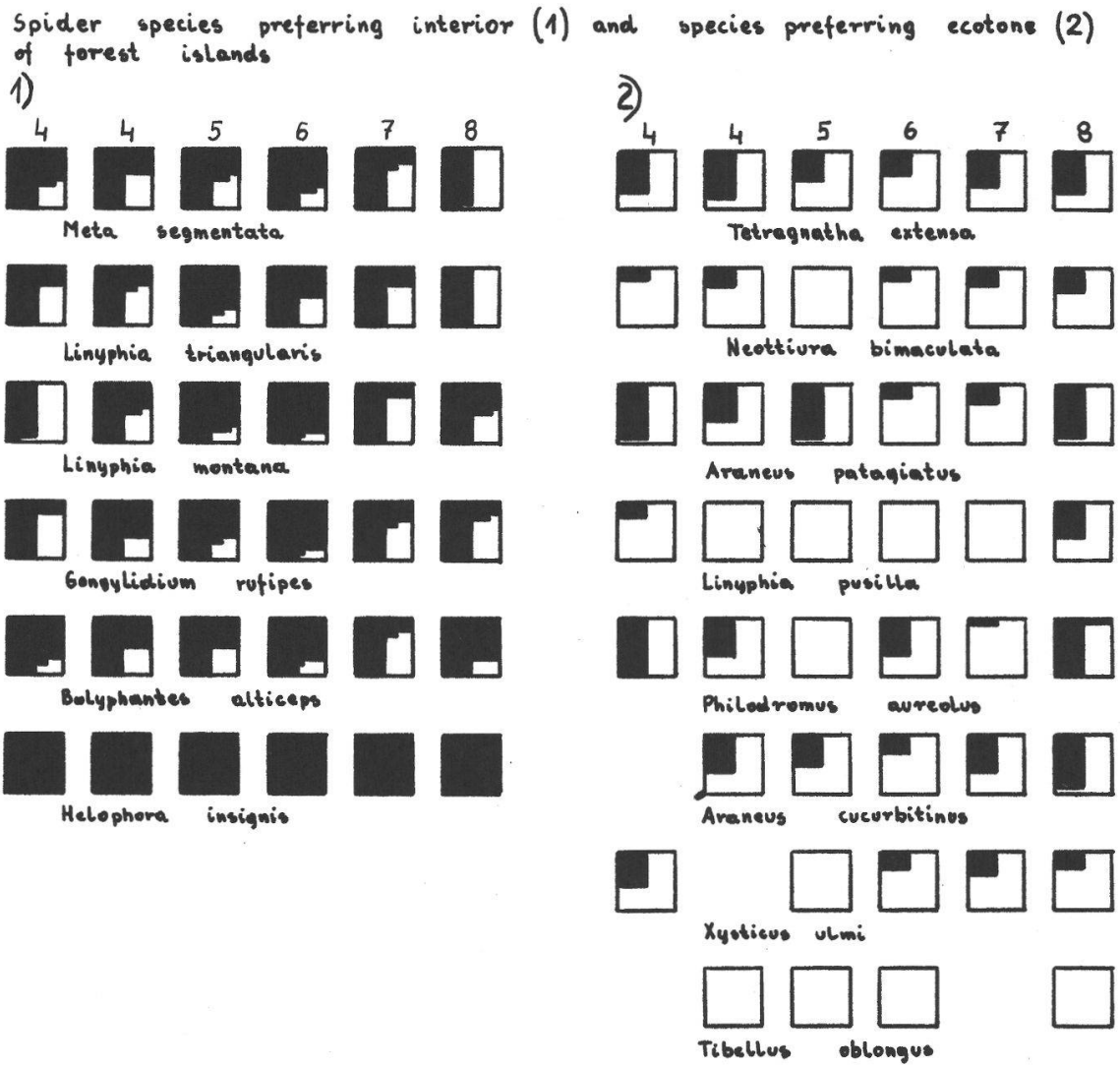
The species showing preference for edges of forest islands comprised *Tetragnatha extensa, Araneus cucurbitinus, Araneus patagiatus, Linyphia pusilla, Neottiura bimaculata, Philodromus aureolus, Xysticus ulmi,* and *Tibellus oblongus* (Table IV). They represent five families.

	Pino-Quercetum				Birch-aspen								M		
Forest islands	4		4		5		6		7		8				
Species	I	E	I	E	I	E	I	E	I	E	I	E	I	E	Total
Araneus cucurbitinus			4	10	9	9	3	12	6	16	10	12	28	67	95
Araneus patagiatus	8	10	10	26	2	6	2	27	5	33	23	28	53	128	181
Tetragnatha extensa	53	95	29	40	12	52	13	82	17	52	40	73	164	394	558
Microlinyphia pusilla	1	8	0	2	0	3	0	2	0	5	2	5	3	25	28
Neottiura bimaculata	6	51	6	42	0	12	1	21	1	9	16	65	30	200	230
Philodromus aureolus	5	7	6	15	0	14	4	11	4	48	26	25	45	118	163
Xysticus ulmi	3	7	0	0	0	6	3	24	4	21	2	15	12	73	85
Tibellus oblongus	0	0	0	4	0	8	0	4	0	0	0	20	0	36	

Table IV: Relative abundance of species preferring marginal part of forest islands /ecotones/ I - inner part E - ecotone

3.3 Concerning "variable 3"

The percentage contribution of spiders occurring in inner and marginal parts of forest islands to the total number of spiders in the forest islands is shown in figure 1. With few exceptions, a clear pattern can be seen for all the islands: higher densities of spider populations either in interiors or in ecotones. Only in the smallest island (no 8), 0.125 ha in size, which can be treated as an ecotone as a whole, the proportions of some species in inner and peripheral parts were different than on the other islands. This was the case of two species of the interior, *M. segmentata* and *L. triangularis*, both dominants, and of ecotone species such as *N. bimaculata, L. pusilla*, and *A. cucurbitinus*. In the preliminary paper on forest islands (LUCZAK 1990) and in the detailed paper (LUCZAK, in print) there is information that the density of spiders was lowest on the smallest 0.125 ha island. On all the other forest islands (35 ha, 13 ha, 1.5 ha,.0.5 ha, 0.5 ha, 0.5 ha), total densities of spiders were not correlated with the sizes of islands, and they were rather similar. The different distribution of some spider species on the smallest forest island was a consequence of differences in ecological conditions as compared with those on all the other islands.



No pattern was found for population densities in interiors or ecotones for Tetragnatha montana, Pachygnatha listeri, and *Enoplognatha ovata*. They reached higher densities sometimes in inner parts of the islands, sometimes in ecotones, or they had similar densities in both these habitat types. They were less susceptible to differences in ecological conditions of ecotones and interiors of forest islands. It has been found, however, that e.g. *E. ovata* reproduces more abundantly in ecotones (TARWIP, in print, TARWID and LUCZAK, in prep.).

3.4 Concerning "variable 4"

In total, 110 species have been recorded over the two study years. The number of species occurring in both the interiors and the ecotones of forest islands ranged from 20 to 29 out of 57-70 species in all the habitat types (island interior, forest ecotone, and cropfields). The species sharing the ecotone and interior of forest islands accounted for 83-92% of the number of spiders in the interiors, and for 80-90% of the number of spiders in the ecotones of forest islands.

The number of species occurring in both the forest ecotones and the surrounding crop fields ranged from 8 to 22, the total number of species in these two habitat types being 57-70. They accounted for 57-73% of the total number of spiders in the ecotones and for 65-83% of the total number of spiders in the crop fields.
The species occurring on only in one, two, or three islands, and the species occurring only one year were numerous, but they were represented by a small number of individuals. These were species from other layers of the ecosystems and rare species.

4. CONCLUSIONS

1. The number of spiders species was higher in ecotones than in interiors of forest islands (Tables I and II).
2. The highest numbers and biomass of spiders occurred in interiors of forest islands, lower in ecotones, and the lowest (minute) in cropfields (Tables I and II).
3. Mean body weight of spiders in ecotones and interiors of forest islands were much higher than in crop fields, where mostly small species and young forms occurred (Tables I and II).
4. Among the abundant species, 6 had higher population densities in interiors of forest islands, 8 had higher densities in ecotones, and 3 species did not show any preference (Tables III and IV, figure 1).
5. The species occurring in both the interiors of forest islands and their ecotones accounted for as many as 80-92% of the total number of species collected from individual forest islands.
6. Spider communities of the inner and marginal parts of forest islands differed in relative numbers and in densities of individual species, but the proportions of species common to the total community of spiders on forest islands were similar (80-92%), and also the species composition was similar
7. Crop fields were characterized by a considerably lower number of species, and by very low numbers and biomass of spiders in the field layer. In this landscape and habitat configuration, ecotone is a barrier precluding dispersal of many spider species from forest islands to crop fields.

REFERENCES

Di CASTRI, F., HANSEN, A.J. & HOLLAND, M.M. - (1988). A new look at ecotones. *Emerging Intern. Projects on landscape boundaries. IUBS, UNESCO, MAB*: 163 pp.

KRAUSE, A. - (1987). Untersuchungen zur Rolle von Spinnen in Agrarbiotopen. *Inst. Bandwirt. Zoologie und Biennenkunde. Doctor's thesis -.Friederich-Wilhelms Univ. zu Bonn*: 308 pp.

LUCZAK, J. - (1986). The distribution of spiders and the structure of.their communi ties under the pressure of agriculture and industry, *In: INRA (ed.))* "Impacts de la structure des paysages agricoles sur la protection des cultures", *Les Colloques de l INRA,* no 36: 85-96.

LUCZAK, J. - (1990). Characteristics of spider communities living in the field-layer of forest islands of differential size. *Proceedings XI Intern. Congress of Arachnology, Turku, 7-12 August 1989. Acta Zool. Fennica,* 190: 249-253. Helsinki (Finland).

LUCZAK, J. - (1991). Ecotone spiders. *Comptes Rendus du XIIème Colloque.européen d'Arachnologie, 2-4 VII 1990. Bull. Soc. eur.d'Arachnologie,* no hors série 1: 235-241. Paris (France).

LUCZAK, J., DABROWSKA-PROT, E. & WOJCIK, Z. - (in prep.). Specyficznosc ekolo giczna stref granicznych (ekotonow) miedzy lasem a polem uprawnym. (Ecological specificity of boundary zones (ecotones) between forest and cultivated field).

NYFFELER, M. - (1982). Field studies on the ecological role of the spiders as insect predators in agroecosystems (abandoned grassland, meadows and cereal fields). *Doctor's thesis, Swiss Federal Institute of Technology, Zurich, Aku-roto druck, Zürich*: 174 pp.

TARWID, M. - (in print). Plodnosc pajaka *Enoplognatha ovata* Cl. w wyspach lesnych w krajobrazie rolniczym polnocno-wschodniej Polski.(Fertility of the spider *Enoplognatha ovata* Cl. in forest islands in agricultural landscape of north-east Poland). *Ekol.Pol.*

TARWID, M. & LUCZAK, J. - (in prep.). Ekotony lesne jako szczegolne srodowiska roz rodu pajaka *Enoplognatha ovata* Cl. (Forest ecotones as special habitats of multi plication of the spider *Enoplognatha ovata* Cl.).

WOJCIK, Z. - (in print). Roslinnosc wysp lesnych w krajobrazie rolniczym zlewni rzeki Jorki na Pojezierzu Mazurskim (polnocno-wschodnia.Polska). (Vegetation of forest islands in agricultural landscape in watershed of river Jorka in Masurian Lakeland). *Ekol.Pol.*

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