1998. P. A. Selden (ed.). *Proceedings of the 17th European Colloquium of Arachnology*, *Edinburgh 1997*.

Dominance structure and seasonal changes in the abundance of dominant epigeic spiders in pastures of northern Greater Poland

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Summary

Studies were undertaken to establish the relative abundance and quantitative dynamics of epigeic spiders in three types of pasture in northern Greater Poland in 1992 and 1993. The localities differed in the composition of plants, type of substrate, and character of the surrounding biotopes. There were eight dominant species in all localities: *Pardosa palustris* (Linnaeus, 1758), *Xerolycosa miniata* (C. L. Koch, 1834), *Xysticus kochi* Thorell, 1872, *Erigone dentipalpis* (Wider, 1834), *Pachygnatha degeeri* Sundevall, 1830, *Pardosa pullata* (Clerck, 1757), *Erigone atra* Blackwall, 1833, and *Oedothorax fuscus* (Blackwall, 1834). Analysis of changes in the abundance of dominant species during a vegetation season revealed a number of successive abundance peaks and the replacement of certain species by others. In May *P. degeeri*, *P. pullata* and *X. kochi* reached peaks of abundance. In June they were replaced by *P. palustris* and *X. miniata*. In August *E. dentipalpis*, in September *E. atra* and *P. degeeri,* and in October *O. fuscus* and *Ostearius melanopygius* (O. P.-Cambridge, 1879) were most abundant. The structure of dominance and fluctuation in the abundance of particular species dominant in a given pasture are affected by the climatic conditions, biocenotic structure and the types of neighbouring ecosystems.

Introduction

The literature provides a large body of data on epigeic spider faunas. The most frequently used method of collection is pitfall trapping. There are a number of papers devoted to faunistic analyses in particular geographically or naturally specific areas such as the Vienna district (Thaler & Steiner, 1993), northern Switzerland (Maurer, 1975), mountainous areas (Thaler *et al*., 1987) and lowlands (Weiss & Andrei, 1989). Another group of faunistic–ecological papers concerns ground spiders living in selected environments like arable fields (Basedow & Rzehak, 1988), xerothermic sites (Thaler, 1985; Bauchhenss, 1990, 1992), woodlands (Koponen, 1980, 1986), hedges (Blick, 1989) or specific plant communities (Polenec, 1978). Ecological aspects considered have been problems of syn- and autecology of epigeic spiders communities (Flatz, 1986; Martin, 1991) and intra-population mechanisms related to competition and predator-prey interactions (Breymeyer, 1970; Kajak, 1960, 1962, 1971, 1978; Kajak *et al*., 1971; Nentwig, 1982).

The studies reported in this work were undertaken to establish the dominance structure and seasonal changes in the abundance of dominant epigeic spiders in pastures of northern Greater Poland.

Material and methods

The material was collected by modified pitfall traps with bait of the "Didonis & Miller" type (Didonis & Miller, 1980). In each study area 18 traps were arranged in 3 rows of 6 traps. The distance between the rows was 100–120 cm, and between traps in each row 150–180 cm. The studies were carried out in 1992–1993, from the beginning of May to the end of October.

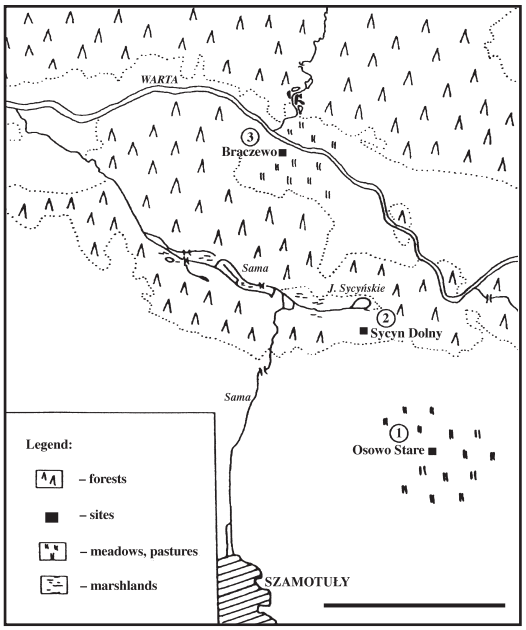

Fig. 1: Map of the study sites. Scale line = 5 km.

Transects were placed in the same positions each year and involved three sites of different biotopic conditions located close to one another. Samples were collected every seven or eight days. Material was sorted and then preserved in 75% ethyl alcohol.

Zoocoenological analysis of spider communities was carried out using the individual dominance index (D), defined as the percentage contribution of specimens of a given species in the total number of specimens collected at a given site. The following classes of individual dominance were assumed after Górny & Grüm (1981): D_5—eudominants > 10%, D_4—dominants 5.1–10%, D_3—subdominants 2.1–5%, D_2—recedents 1.1–2%, D_1—subrecedents < 1%.

Study sites

The studies were conducted in northern Greater Poland which geographically belongs to Greater Poland–Kujawy Lowland. The spiders occurring in this region have been well studied. Recently, A. Dziabaszewski (1989, 1991, 1995), W. Dziabaszewski (1992) and Szymkowiak (1993) have discovered a few rare species to add to the list of spiders known from this area. The three study sites lie in the vicinity of the town of Szamotuły, located about 38 km northwest of Poznań. Its natural north and east border is the valley of the River Warta. The area is slightly undulating with a mean height of 75–100 m above sea level. The area was once covered with oak–hornbeam forests (Kondracki, 1988), but with the development of cultivation the land was transformed into fields, meadows and pastures.

Site 1— Osowo Stare: About 5 km north-east of Szamotuły, in Osowo Stare village (Fig. 1). Meadows and pastures occupy a low percentage of the area and have been established on both sandy and swampy ground. Meadows are included in the Arrhenatherion alliance from the Molinio-Arrhenatheretea class (Matuszkiewicz, 1984). The area of study is a pasture amongst fields vegetated with high clumps of spreading grasses including a significant contribution of Rye grass (*Arrhenatherum elatius*) and Orchard grass (*Dactylis glomerata*). Where the elevation is lower, the contribution of bryophytes and rushes increases. The transect was made on a drained mound. There was no afforestation in the vicinity of the pasture.

Site 2—Sycyn Dolny: In Sycyn Dolny village, about 8 km north of Szamotuły (Fig. 1). The pasture studied is a large forest clearing near the overgrown eutrophic Sycyn Lake, merging into swamps. The clearing is surrounded by a thick pine stand growing on dry ground. From the phytosociological point of view there are different transient variants from associations of the Crynephorera class (Matuszkiewicz, 1984) to freshwater marshy sedges of the Scheuchzerio-Caricetea fuscae class (Szoszkiewicz, 1971). The transect was made on a sandy area in the clearing. This site is dominated by clumpy grass with a large contribution of sedge in lower-lying land and perennial communities on sandy elevations.

Site 3—Brączewo: On the banks of the River Warta in Brączewo village, about 12 km north of Szamotuły (Fig. 1). The pasture is situated on a dry, strongly sunlit, 5 m high flood-terrace of highly mosaic growth with different transient variants of plant associations from the Molinio-Arrhenatheretea class (Matuszkiewicz, 1984). The vegetation is dominated by low spreading and tussock grass, Cinquefoil (*Potentilla* sp.) and Yarrow (*Achillea millefolium*) with isolated aspen trees. Throughout the period of the study

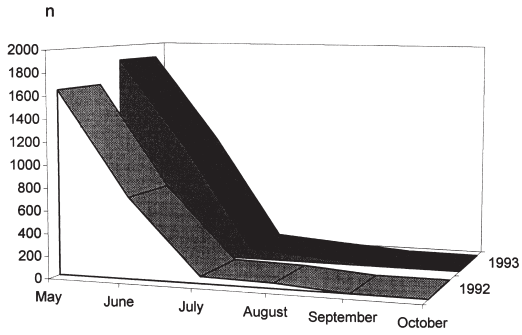

Fig. 2: Fluctuations in abundance of *Pardosa palustris* (Linnaeus, 1758) at the site in Osowo Stare.

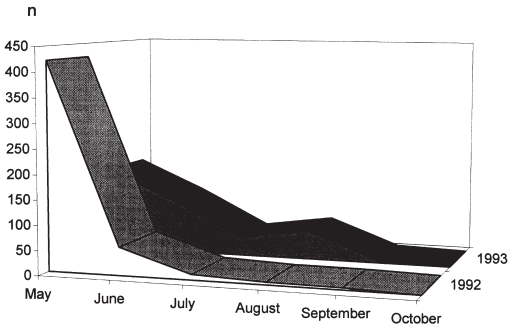

Fig. 3: Fluctuations in abundance of *Pardosa pullata* (Clerck, 1757) at the site in Osowo Stare.

we did not observe any flooding. The transect lies in a strongly sun-lit flat part of the area.

Results

The material collected totalled 18,995 specimens comprising 138 species belonging to 17 families. Analysis of the contribution of particular species enabled the determination of the dominance structure of spider communities at the three sites.

Dominance structure and seasonal changes in species dominance

A group of species dominating in a given month is defined as those whose dominance index is 5.1–100% (eudominants or dominants). The species dominant from May to October in 1992 and 1993 are given in Table 1. Because of the small number of specimens collected at Brączewo in October 1992, no dominance structure was calculated.

Site 1— Osowo Stare. The 10,451 specimens collected represented 92 species. Calculation of the individual dominance index revealed: D_5— *Pardosa palustris* (Linnaeus, 1758) (52.8 %); D_4—*P. pullata* (Clerck, 1757) (8.4%), *Pachygnatha degeeri* Sundevall, 1830 (5.6%); D_3—7 species; D_2—3 species; D_1—79 species. The index of individual dominance of *P. palustris* reached 40–70% in seven of the twelve months of study. The second most abundant species was *P. pullata* which was eudominant in four of the months of study. Its contribution was less than that of *P. palustris*, but in a few months its index was the second highest. These species dominated in spring and summer. In September and October the sequence of species with the highest index of dominance changed and the following species appeared in the group of eudominants: *Tegenaria agrestis* (Walckenaer, 1802), *Centromerita concinna* (Thorell, 1875), *C. bicolor* (Blackwall, 1833), *Tiso vagans* (Blackwall, 1834), *Pisaura mirabilis* (Clerck, 1757), *Pachygnatha degeeri* and *Oedothorax fuscus* (Blackwall, 1834).

*Site 2—Sycyn Dolny***.** The 2302 specimens collected belonged to 83 species. Calculation of individual dominance index showed: D_5— *Xerolycosa miniata* (C. L. Koch, 1834) (27.6%), *Pardosa palustris* (25.0%), *Xysticus kochi* Thorell, 1872 (15.9%); D_4—absent; D_3—3 species; D_2—4 species; D_1—73 species. The

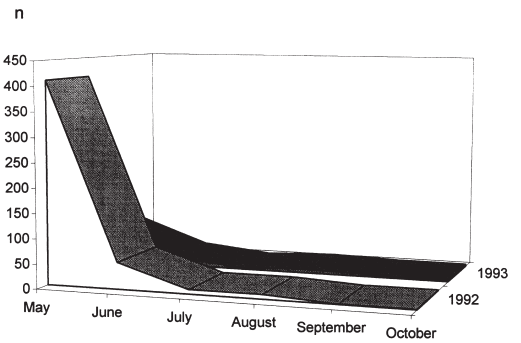

Fig. 4: Fluctuations in abundance of *Pachygnatha degeeri* Sundevall, 1830 at the site in Osowo Stare.

Locality	Year	Month / domination											
		May	D [%]	June	D [%]	July	D [%]	August	D [%]	September	D [%]	October	D [%]
Osowo Stare Site 1	1992	*Pardosa palustris*	42	*Pardosa palustris*	60,8	*Pardosa palustris*	38,2	*Pardosa palustris*	49,5	*Tegenaria agrestis*	34,5	*Centromerita concinna*	48,1
		Pardosa pullata	10,7			*Pardosa pullata*	6,7	*Pachygnatha degeeri*	9,3	*Tiso vagans*	13,8	*Pisaura mirabilis*	25,9
		Pachygnatha degeeri	10,5			*Tibellus oblongus*	6,7	*Erigone dentipalpis*	7,2	*Pardosa pullata*	13,8	*Erigone dentipalpis*	7,4
		Pardosa amentata	5,9			*Erigone dentipalpis*	6,1	*Pardosa pullata*	5,15	*Centromerita concinna*	6,9	*Erigone atra*	7,4
		Xysticus cristatus	5,3			*Tiso vagans*	5,45			*Erigone dentipalpis*	6,9		
						Pachygnatha degeeri	5,45			*Pisaura mirabilis*	6,9		
	1993	*Pardosa palustris*	67,3	*Pardosa palustris*	67,9	*Pardosa palustris*	30	*Pardosa prativaga*	18,7	*Pardosa prativaga*	20	*Centromerita bicolor*	20,8
		Pardosa agrestis	9,8	*Pardosa pullata*	7,1	*Pardosa pullata*	11,45	*Pardosa pullata*	17,8	*Trochosa ruricola*	18,5	*Pachygnatha degeeri*	16,7
		Pardosa pullata	6,2	*Pardosa prativaga*	5,7	*Pardosa prativaga*	11,45	*Tiso vagans*	17,8	*Oedothorax fuscus*	13,85	*Erigone atra*	8,3
				Pardosa agrestis	6,5	*Oedothorax fuscus*	11,1	*Pardosa palustris*	14,4	*Tegenaria agrestis*	12,3	*Pardosa prativaga*	8,3
						Erigone dentipalpis	8,7	*Pardosa agrestis*	6,1	*Pardosa pullata*	6,15	*Leptyphantes tenuis*	8,3
						Tiso vagans	7,1			*Pachygnatha degeeri*	6,15		
						Pardosa agrestis	6,2			*Pardosa agrestis*	6,15		
						Erigone atra	6,2						
Sycyn Dolny Site 2	1992	*Xysticus kochi*	43,5	*Pardosa palustris*	31,6	*Xerolycosa miniata*	47,1	*Alopecosa schmidti*	30,8	*Pardosa palustris*	45	*Pisaura mirabilis*	37,4
		Pardosa palustris	20,2	*Xerolycosa miniata*	31,2	*Pardosa palustris*	19,1	*Pardosa palustris*	21,15	*Pardosa pullata*	12,1	*Meioneta rurestris*	11,1
		Pachygnatha degeeri	9	*Pachygnatha degeeri*	7,7	*Meioneta rurestris*	7,35	*Xerolycosa miniata*	21,15	*Pardosa agrestis*	6	*Pachygnatha degeeri*	7,4
		Xysticus cristatus	5,9	*Xysticus kochi*	6,8			*Ostearius melanopygius*	7,7	*Xerolycosa miniata*	5,4	*Gongylidiellum murcidum*	7,4
								Tegenaria agrestis	5,8				
								Zelotes subterraneus	5,8				
	1993	*Xerolycosa miniata*	51,55	*Xerolycosa miniata*	43,4	*Xerolycosa miniata*	68,4	*Xerolycosa miniata*	31,5	*Tegenaria agrestis*	52,2	*Ostearius melanopygius*	32,1
		Xysticus kochi	19,9	*Pardosa palustris*	37,1	*Pardosa palustris*	16,1	*Pardosa palustris*	23,1	*Pardosa palustris*	8,7	*Pelecopsis parallela*	14,3
		Pardosa palustris	16,8	*Enoplognatha thoracica*	5,6	*Meioneta rurestris*	5,2	*Meioneta rurestris*	12,6	*Xerolycosa miniata*	8,7	*Tegenaria agrestis*	10,7
								Erigone atra	8,4	*Erigone atra*	8,7	*Araneus quadratus*	7,1
								Ostearius melanopygius	6,3				
Brączewo Site 3	1992	*Erigone dentipalpis*	37,5	*Pardosa palustris*	46	*Erigone dentipalpis*	52,75	*Erigone dentipalpis*	52,2	*Erigone dentipalpis*	24,5		–
		Pachygnatha degeeri	16,7	*Xerolycosa miniata*	13	*Erigone atra*	15,4	*Erigone atra*	20,65	*Erigone atra*	16,4	Low specimen number	–
		Pardosa palustris	14,5	*Xysticus kochi*	13	*Pachygnatha degeeri*	8,8	*Pachygnatha degeeri*	9,8	*Meioneta rurestris*	13,1		–
		Xysticus kochi	7,25	*Erigone atra*	10,9	*Xerolycosa miniata*	7,7			*Pachygnatha degeeri*	9,8		–
		Erigone atra	5,7			*Meioneta rurestris*	5,5			*Sitticus distinguendus*	8,2		–
	1993	*Pardosa palustris*	75,9	*Pardosa palustris*	62,55	*Erigone dentipalpis*	55,7	*Erigone dentipalpis*	66,7	*Erigone dentipalpis*	44,4	*Oedothorax fuscus*	49
				Erigone dentipalpis	8,9	*Erigone atra*	13,5	*Erigone atra*	11,3	*Pachygnatha degeeri*	19,2	*Erigone dentipalpis*	26,6
				Erigone atra	5,1	*Pachygnatha degeeri*	8,3	*Pachygnatha degeeri*	8,9	*Oedothorax fuscus*	12,6	*Pachygnatha degeeri*	10,4
						Pardosa palustris	7,8			*Erigone atra*	6,6		
						Meioneta rurestris	6,25						

Table 1: Seasonal changes in species dominance at each site.

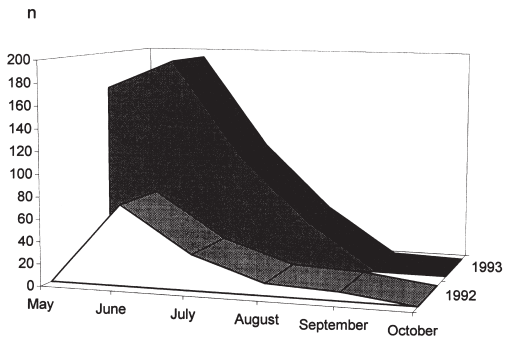

Fig. 5: Fluctuations in abundance of *Xerolycosa miniata* (C. L. Koch, 1834) at the site in Sycyn Dolny.

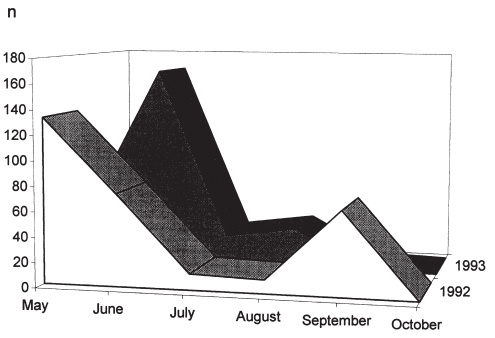

Fig. 6: Fluctuations in abundance of *Pardosa palustris* (Linnaeus, 1758) at the site in Sycyn Dolny.

contribution of two species, *P. palustris* and *X. miniata*, was the greatest from June to August. Apart from these two species, this site was characterized by large numbers of *X. kochi*, eudominant in May, and *Alopecosa schmidti* (Hahn, 1835) and *Meioneta rurestris* (C. L. Koch, 1836), eudominants in August. In September and October the group of eudominants was extended to include: *Pardosa pullata, Tegenaria agrestis*, *Pisaura mirabilis*, *Ostearius melanopygius* (O. P.-Cambridge, 1879), and *Pelecopsis parallela* (Wider, 1834).

Site 3—Brączewo. The 2166 specimens collected belonged to 69 species. Calculation of the individual dominance index showed: D_5—*Erigone dentipalpis* (Wider, 1834) (36.7%), *Pardosa palustris* (23.3%); D_4—*Pachygnatha degeeri* (9.5%), *Erigone atra* Blackwall, 1833 (7.9%), *Oedothorax fuscus* (5.3%); D_3—2 species; D_2—2 species; D_1—60 species. At this site, in May and June the species with the highest dominance was *Pardosa palustris*. Other eudominants in these months were: *Erigone dentipalpis*, *E. atra*, *Pachygnatha degeeri*, *Xerolycosa miniata*, and *Xysticus kochi*. In September the contribution of *E. dentipalpis* decreased and, as a result, *Meioneta rurestris* (C. L. Koch, 1836), *Pachygnatha degeeri* and *Oedothorax fuscus* became more important, with the latter reaching 49% in October 1993.

Phenology

The material collected in the two years included eight species belonging to the classes of eudominants and dominants. For these species seasonal changes in absolute abundance were determined in each year and at each site.

Site 1— Osowo Stare. Changes in abundance of *Pardosa palustris* (eudominant) are similar in the two years, the only difference being slightly fewer specimens in 1992 (Fig. 2). The abundance of *P. pullata*, a dominant, was greatest in May in both years, and decreased until September (Fig. 3). In 1992 its abundance decreased gradually, while in 1993 small fluctuations were observed. Fluctuations in the abundance of *Pachygnatha degeeri* were similar in both years (Fig. 4), and resembled those of *Pardosa palustris*, with decrease in abundance of the former more rapid in June. It is interesting to note that in 1992 its numbers were four times greater than in 1993 at this site. In general, the fluctuations of abundance of these three species between the two years are similar.

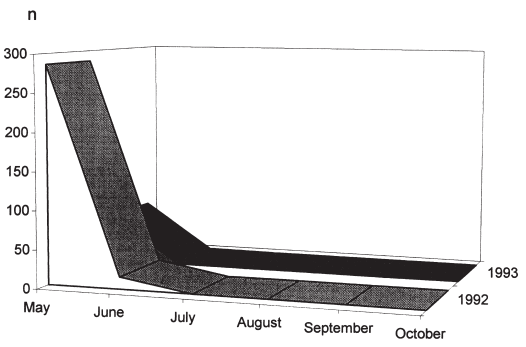

Fig. 7: Fluctuations in abundance of *Xysticus kochi* Thorell, 1872 at the site in Sycyn Dolny.

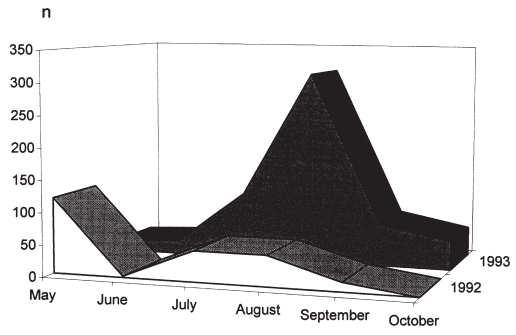

Fig. 8: Fluctuations in abundance of *Erigone dentipalpis* (Wider, 1834) at the site in Brączewo.

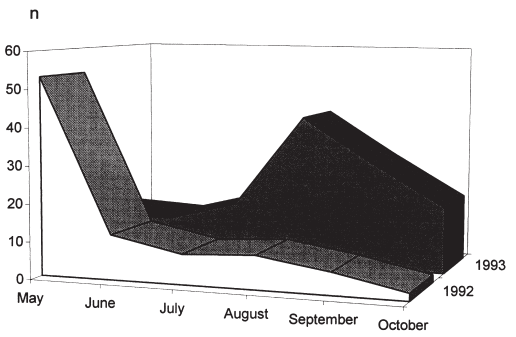

Fig. 9: Fluctuations in abundance of *Pachygnatha degeeri* Sundevall, 1830 at the site in Brączewo.

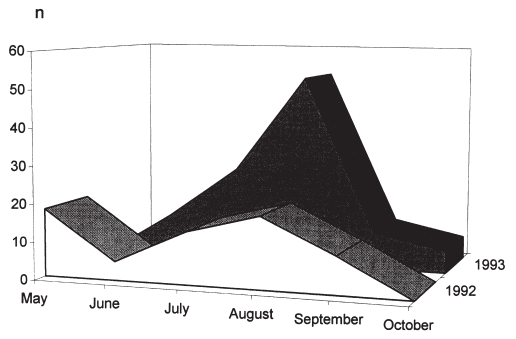

Fig. 10: Fluctuations in abundance of *Erigone atra* Blackwall, 1833 at the site in Brączewo.

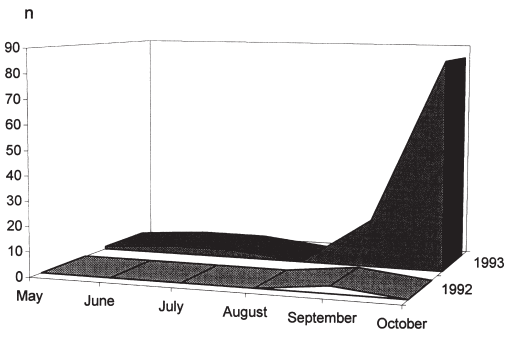

Fig. 11: Fluctuations in abundance of *Oedothorax fuscus* (Blackwall, 1834) at the site in Brączewo.

*Site 2—Sycyn Dolny***.** Changes in the abundance of *Xerolycosa miniata*, a eudominant, are similar in the two years (Fig. 5). In both, the maximum number of specimens appeared in June, and thereafter decreased until September. For *Pardosa palustris*, another eudominant, the changes in abundance in the two years were different (Fig. 6). In 1992 high numbers appeared in May and September. In 1993 the maximum numbers appeared in June and thereafter remained at a low level. The third eudominant, *Xysticus kochi*, was most abundant at the beginning of May, and then decreased rapidly. In 1992 over 4.5 times more specimens were collected (Fig. 7).

Site 3—Brączewo. The changes in abundance of *Erigone dentipalpis*, a eudominant, were considerably different in the two years (Fig. 8). In 1993 the numbers were over twice those in 1992. For *Pardosa palustris*, another eudominant, the changes in the two years are rather similar to those at site 1. *Pachygnatha degeeri* was a dominant at this site, but the changes in its abundance in the two years were different (Fig. 9). In 1992 it was abundantly represented in May, but in 1993 reached a high abundance in August. The abundance of another dominant at this site, *Erigone atra*, showed rather smooth fluctuations in 1992, while in 1993 the changes were more pronounced with a distinct peak in August (Fig. 10). The presence of the third dominant at this site, *Oedothorax fuscus*, was discontinuous. From May until July only a few specimens of this species appeared while in September and October they were most abundant (Fig. 11).

Discussion and conclusions

Analysis of the structure of dominance of spiders found at all sites studied in the period

from May to October each year, identified eight key species: *Pardosa palustris, P. pullata, Xerolycosa miniata, Xysticus kochi, Erigone dentipalpis, E. atra, Pachygnatha degeeri,* and *Oedothorax fuscus*.

The seasonal distribution of the index of dominance revealed that there are many species (29) whose dominance in particular months reached high values (Table 1). At site 1, *Pardosa palustris* reached the highest values for most of the trapping season. This species prefers moderately humid places in meadows and fields under cultivation (Prószyński & Staręga, 1971). Lower values of the index of dominance were found for *P. prativaga* (L. Koch, 1870) and *P. pullata*. These species choose more humid spots (Prószyński & Staręga, 1971), so their individual contribution was not as high as that of *P. palustris*. The preferences of these species are also evident when analysing their dominance indices in particular months of 1992 and 1993. The dominance index of *P. palustris* was higher in 1992 while the indices of *P. prativaga* and *P. pullata* were higher in 1993. This corresponds to the changes in humidity level, as the mean daily precipitation in 1992 was 1.70 mm while in 1993 it was 4.22 mm. This increase in humidity was most probably the reason why dominance of *P. prativaga* in August and September 1993 was so high. Site 2 was characterized by the highest individual contribution of *Xysticus kochi* in May and *P. palustris* and *Xerolycosa miniata* alternately in the other months. *X. kochi* prefers the litter of dry pine forests (Prószyński & Staręga, 1971) and its appearance in the pastures was related to the close neighbourhood of such forest. *X. miniata* prefers dry sandy conditions (Prószyński & Staręga, 1971) and at this site it found its favourite habitat. At site 3, one of the most abundant species was *P. palustris*; however, apart from this species there were two other eudominants: *Erigone dentipalpis* and *E. atra* which did not appear as dominants at the other sites. Representatives of these species supplanted lycosid species which are usual dominants during the spring and summer. The character of this biotope—a riverside pasture—favours the appearance of aeronaut species such as *E. dentipalpis* and *E. atra*. Most probably these species had reached the site through migration along the river banks.

One species, *Pachygnatha degeeri*, was common to all three sites; although it did not take the highest position in terms of abundance in any of the months of study, in many months its relative abundance was high enough for it to be classified as eudominant. Therefore, *P. degeeri* should be regarded as a constant element of the spider arachnofauna.

Analysis of changes in the abundance of dominant species during a vegetation season reveals a number of successive abundance peaks and replacement of certain species by others. In May *P. degeeri*, *P. pullata* and *X. kochi* reached peaks of abundance. In June the numbers of these species rapidly decreased and they were replaced by *P. palustris* and *X. miniata*. In summer the epigeic spiders became much less abundant and in July no species was observed to reach a peak of abundance in the three localities studied. The species of Lycosidae gave way to those from the families Erigonidae and Tetragnathidae. In August we noted peaks of abundance for *E. dentipalpis*, *E. atra*, and *P. degeeri*, while in September and October *Oedothorax fuscus* and *Ostearius melanopygius* were most abundant.

The structure of dominance and fluctuation in the abundance of particular species dominant in a given pasture are affected by the climatic conditions, biocenotic structure and the types of neighbouring ecosystems.

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References

BASEDOW, T. & RZEHAK, K. 1988: Abundanz und Aktivitätsdichte epigäischer Raubarthropoden auf Ackerflächen—ein Vergleich. *Zool. Jb.* (*Syst.*) **115**: 495–508.

BAUCHHENSS, E. 1990: Mitteleuropäische Xerotherm-Standorte und ihre epigäische Spinnenfauna—eine autökologische Betrachtung. *Abh. Verh. naturw. Ver. Hamburg* **31/32**: 153–162.

BAUCHHENSS, E. 1992: Epigäische Spinnen an unterfränkischen Muschelkalkstandorten. *Abh. naturw. Ver. Würzburg* **33**: 51–73.

BLICK, T. 1989: The relationships of the epigeic spider fauna (Arachnida, Araneae) between hedges and the surrounding land. *Mitt. dt. Ges. allg. angew. Ent.* **7**: 84–89.

BREYMEYER, A. 1970: The rate of reduction of the density and the change in the biomass of the *Lycosa pullata* (Clerck) (Lycosidae, Araneida) population in a meadow environment. *Bull. Mus. natn. Hist. nat. Paris* **41** (Suppl. 1): 211–216.

DIDONIS, L. & MILLER, J. 1980: Host-finding response of onion and seedcorn flies to healthy and decomposing onions and several synthetic constituents of onion. *Environ. Entomol.* **9**: 467–472.

DZIABASZEWSKI, A. 1989: Uwagi faunistyczne o rzadkich gatunkach pająków (Aranei) z Poznania (z listą 302 stwierdzonych gatunków). *Badan. fizjogr. Pol. zachod. Ser. C* **38**: 5–21.

DZIABASZEWSKI, A. 1991: Nowe gatunki pająków (Aranei) dla miasta Poznania, III. *Pr. Kom. mat.-przyr. Poznań TPN* **73**: 27–34.

DZIABASZEWSKI, A. 1995: Pająki (Aranei) zabudowań Poznania. *Badan. fizjogr. Pol. zachod.* Ser. C **42**: 7–38.

DZIABASZEWSKI, W. 1992: Pogońce (Lycosidae s. lat.) łęgów rogalińskich. *Morena* **1**: 39–41.

FLATZ, U. 1986: Zur Biologie und Ökologie epigäischer Wiesenspinnen des Innsbrucker Mittelgebirges (Nordtirol, Österreich). *In* J. A. Barrientos (ed.). *Actas X Congreso Internacional de Aracnología Jaca* (*España*), **I**. Barcelona: Instituto Pirenaico de Ecología (C.S.I.C.) and Grupo de Aracnología (Assoc. esp. Entomol.): 225–230.

GÓRNY, M. & GRÜM, L. 1981: *Metody stosowane w zoologii gleby*. Warszawa, PWN.

KAJAK, A. 1960: Zmiany liczebności pająków na kilkułąkach. *Ekol. pol.* **13**: 199–228.

KAJAK, A. 1962: Comparison of spider fauna in artificial and natural meadows. *Ekol. pol.* **10**: :1–20.

KAJAK, A. 1971: Productivity investigation of two types of meadows in the Vistula valley. IX. Production and consumption of field layer spiders. *Ekol. pol.* **19**:197–211.

KAJAK, A. 1978: The effect of fertilizers on numbers and biomass of spiders in a meadow. *In* P. Merrett (ed.). *Arachnology.* Symposia of the Zoological Society of London, No. 42. London and New York: Academic Press: 125–129.

KAJAK, A., BREYMEYER, A. & PĘTAL, J. 1971: Productivity investigation of two types of meadows in the Vistula valley. XI. Predatory arthropods. *Ekol. pol.* **19**: 223–233.

KONDRACKI, J. 1988: *Geografia fizyczna Polski*. Warszawa: PWN.

KOPONEN, S. 1980: Epigeic spider fauna of subarctic birch woodlands. *In* J. Gruber (ed.). *8. Internationaler Arachnologen-Kongreß Wien 1980 Verhandlungen*. Vienna: H. Egermann: 415–420

KOPONEN, S. 1986: Epigeic spiders of a young plantation in northern marginal pine forest, Finnish Lapland. *In* J. A. Barrientos (ed.). *Actas X Congreso Internacional de Aracnología Jaca* (*España*), **I**. Barcelona: Instituto Pirenaico de Ecología (C.S.I.C.) and Grupo de Aracnología (Assoc. esp. Entomol.): 273.

MARTIN, D. 1991: Zur Autökologie der Spinnen (Arachnida: Araneae) I. Charakteristic der Habitatausstattung und Präferenz-verhalten epigäischer Spinnenarten. *Arachnol. Mitt.* **1**: 5–26.

MATUSZKIEWICZ, W. 1984: *Przewodnik do oznaczania zbiorowisk róslinnych Polski*. Warszawa: PWN.

MAURER, R. 1975: Epigäische Spinnen der Nordschweiz I. *Mitt. schweiz. ent. Ges.* **48**: 357–375.

NENTWIG, W. 1982: Epigeic spiders, their potential prey and competitors: relationship between size and frequency. *Oecologia* **55**: 130–136.

POLENEC, A. 1978: Zusammensetzung und Besonderheiten der Epigäischen Spinnenfauna des Seslerio-Ostryetum am Berge Slavnik (1028M) Nord-Istrien, Jugoslawien. *In* P. Merrett (ed.). *Arachnology.* Symposia of the Zoological Society of London, No. 42. London and New York: Academic Press: 367–377.

PRÓSZYŃSKI, J. & STAREĘGA, W. 1971: *Pająki* (*Aranei*). *Katalog Fauny Polski* XXXIII, *Nr 16*. Warszawa: PWN.

SZOSZKIEWICZ, J. 1971: *Przewodnik do ćwiczeń z uprawy łąk i pastwisk*. Poznań: PWN.

SZYMKOWIAK, P. 1993: Pająki Aranei rezerwatu przyrody "Mielno". *Parki nar. Rez. przy.* **12**: 59–76.

THALER, K. 1985: Uber die epigäische Spinnenfauna von Xerothermstandorten des Tiroler Inntales (Österreich) (Arachnida: Aranei). *Veröff. Mus. Ferdinandeum Innsb.* **65**: 81–103.

THALER, K., AMANN, H., AUSSERLECHNER, J., FLATZ, U. & SCHOFFTHALER, H. 1987: Epigäische Spinnen (Arachnida: Aranei) im Kulturland des Innsbrucker Mittelgebirges (900 m, Nordtirol, Österreich). *Ber. naturw.-med. Ver. Innsbruck* **74**: 169–184.

THALER, K. & STEINER, H. M. 1993: Zur epigäischen Spinnenfauna des Stadtgebietes von Wien (Österreich)—nach Aufsammulungen von Prof. Dr W. Kühnelt. *Ber. naturw.-med. Ver. Innsbruck* **80**: 303–310.

WEISS, I. & ANDREI, G. 1989: Die epigäische Spinnenfauna (Arachnida, Araneae) aus zwei Wäldern der Donautiefebene, Süd-Rumänien. *Trav. Mus. Hist. nat. "Gr. Antipa"* **30**: 335–346.