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ANALYSIS OF THE EFFECT OF MINERAL FERTILIZATION ON THE MEADOW SPIDER COMMUNITY*

ABSTRACT: The influence of high doses of NPK fertilizers has been examined as regards the density of spiders, size of individuals, degree of penetration of the area and changes in the pattern of dominant species. Changes occurring immediately after first fertilization have been taken into consideration and also tendencies over the 8 years of fertilizing. Intensive fertilization results in changes in the dominance structure. Large, mobile species (Lycosidae) are replaced by smaller, sedentary ones (Linyphiidae). In the course of years the differences between fertilized and not fertilized plots are becoming less distinct.

KEY WORDS: Mineral fertilizing, meadow, spider community, field experiment.

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1. INTRODUCTION, CHARACTERISTICS OF THE SITE

Changes in communities of epigeic spiders during 8 years of meadow fertilization have been analysed. The following parameters have been taken into consideration: density of the

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total spider community and of dominant species, penetration of the area by spiders, weight of individuals, species diversity. The material presented is a fragment of team research in this area on the effect of mineral fertilization on the functioning of the meadow ecosystem (Traczyk 1976a, 1978) and thus the changes in spider communities can be related to other processes.

In previous papers (Kajak 1977, 1980) it has been indicated that predatory arthropods in meadow turf react to main agrotechnical treatments by rapid decrease of total biomass. Their reaction is stronger than of representatives of other trophic levels. Thus it can be expected that changes in spider communities, one of the dominant group of predators, can indicate the direction of the changes in this trophic level due to fertilization.

The fertilization experiment was started in 1972 on permanent meadow near Warsaw, mown twice during a season, of the community *Arrhenatheretum medioeuropaeum* (Traczyk 1976a).

In order to reduce the effect of area differentiation the meadow was divided into 18 plots, each 1250 m² of surface area, and 6 identically fertilized. Each year the fertilization was as follows: 280 kg NPK · ha⁻¹ (variant I), 680 kg NPK · ha⁻¹ (variant II) and no fertilizers on control plots (variant 0). Nitrogen and potassium were introduced in three doses: at the beginning of the growing season, after the first and second mowing; phosphorus fertilization was applied once, in spring.

On the area examined alluvial brown gleyed soils prevailed. In depressions and eminences there were parts with other types of soils. A detailed description of the site is given in the paper by Traczyk, Czerwiński and Kotowska (1976).

Fertilization causes considerable changes in the top soil layer (Czerwiński and Pracz 1978). The acidity of soil increases, cation exchange capacity decreases and there are losses of exchangeable Ca and Mg. In the three first years of the experiment these unfavourable symptoms have increased (Czerwiński and Pracz 1978), afterwards the element content became more stable (Z. Czerwiński — personal communication).

Changes in chemical composition of soil also took place on control plots. Organic carbon content there was lower than on fertilized plots (Łakomieć 1978). Also losses of Ca and Mg ions in the cation exchange capacity were observed, although not to such extent as after the application of fertilizers. Losses of K⁺ exchangeable ions were observed (Czerwiński and Pracz 1978) (Table I). This was probably due to the fact that these plots were systematically mown similarly as the fertilized plots but the matter was not replenished.

Fertilization caused a 3–4-fold yield increase (Traczyk, Traczyk and Pasternak 1976a). However, the changes in biomass of plant parts remaining on the field after harvest (rhizomes, roots) were not high (Plewczyńska-Kuraś 1976, Traczyk, Traczyk and Pasternak 1976b). Changes in yield in successive years proved further soil deterioration on unfertilized plots (Table II).

During the seven years of the experiment yields decreased on control plots, whereas on fertilized plots they increased (Table II).

Thus the experiment caused changes in soil and vegetation of both types of plots. In time these differences between plots change.

This analysis, on the example of spider community, has been made to find whether differences between plots become obliterated or increase in the course of years.

Table I. Losses in the content of exchangeable cations in top soil in the third year of experiment, as compared with the first year (after Czerwiński and Prac 1978)

0 – control plots, I – moderately fertilized plots, II – heavily fertilized plots

Plots	Per cent of content losses in the first year		
	Ca ⁺⁺	Mg ⁺⁺	K ⁺
0	-7.2	-2.3	-30.0
I	-14.6	-11.8	-22.7
II	-23.3	-16.2	-9.2

Table II. Changes in mean annual yield in g · d. wt · m⁻² · year⁻¹ (after Traczyk, Traczyk and Pasternak – unpublished data)

0 – control plots, I – moderately fertilized plots, II – heavily fertilized plots

Year of experiment	Plots		
	0	I	II
1972 (1st)	529	682	993
1973 (2nd)	329	645	1114
1978 (7th)	315	695	1141
Gains or losses in the 7th year in per cent of the yield for 1st year	-39	+2	+15

2. METHODS

In order to estimate the effect of fertilization the same number of samples was taken from fertilized and non fertilized plots on the same day or in two successive days. Studies were mainly conducted on intensively fertilized plots and on control ones. Plots fertilized with intermediate doses were less frequently explored, only to check whether the reaction of spider community is intermediate as well as the doses.

In order to estimate the spider density two methods were used:

1. Soil corer of a surface area 100 cm² was used for soil sampling down to the depth of 5 cm. Animals were extracted in Tullgren apparatus modified by Kempson, Lloyd and Ghelardi (1963). Each series contained 30 samples. Mainly small spiders are caught using this method. Over two years (1973, 1974) samples were taken every month between April and October. This method was less frequently used in the following years (Table III), because it provided scarce material, so the second method was given the preference.

2. Quadrature method – detailed survey and collection of spiders from metal frames of sur-

face area 625 cm². Each series consisted of 10 samples. This method was used mainly in periods of maximal numbers of spiders, i.e. in spring and autumn.

In order to estimate the intensity of penetration the area by spiders, pitfall traps of Barber type were used. These were plastic pots of a diameter 6.5 cm, 10 cm deep, containing ethylene glycol as a preservative, placed in one or several rows. Each series of samples consisted of 10–20 traps open for 2 days. Data on the number of samples taken in successive years are presented in Table III.

Table III. Number of samples taken

Methods	Year from the beginning of experiment					
	1972 1	1973 2	1974 3	1975 4	1976 5	1979 8
Soil cores	—	360	360	300	60	—
Quadrat method	—	—	78	58	20	90
Pitfall traps	700	230	—	385	120	100

All animals obtained were measured. Basing on the material collected without using preservatives, the relation between the body length and dry weight of individuals was calculated. Such relations were determined separately for each species, growth stage, and for females and males.

In estimating the significance of differences between the plots Student *t*-test was used.

Also the species diversity¹ was estimated using two indices – Simpson's index and Shannon-Weaver's index (P e t 1974). These indices were chosen, because they take into consideration not only the number of species on a given area, but also the number of individuals of particular species.

The following equations were used to estimate the index on the basis of a finite number of samples:

$$\text{Simpson's index: } D = 1 - \sum_{i=1}^s \frac{n_i(n_i - 1)}{n(n - 1)}$$

$$\text{Shannon-Weaver's index: } H = - \sum_{i=1}^s \frac{n_i}{n} \log \frac{n_i}{n}$$

where: *s* – number of species in samples, *n_i* – number of individuals of species *i*, *n* – number of all individuals caught.

¹The appendix contains the list of found species.

3. RESULTS

3.1. DENSITY, WEIGHT, LOCOMOTORY ACTIVITY OF POPULATION

Fertilization does not influence in fact the density of spiders. Density estimated by the quadrature method was similar on the fertilized and non-fertilized plots. In two years (out of 3 years compared) the density of spiders on intensively fertilized plots exceeded that on control plots, but these were insignificant differences (Table IV). Only in 1973, on the basis of soil cores, the density on fertilized plots was significantly higher. In the next years an opposite tendency was observed, but the differences were insignificant. The density of spiders usually fluctuated between 20–40 individuals per 1 m². Such density had been frequently recorded on intensively cultivated and utilized meadows (Delchev and Kajak 1974).

Table IV. Mean density of spiders (number of individuals · m⁻²)
I – moderately fertilized plots, II – heavily fertilized plots

Year	Soil cores		Quadrature method		
	control plots	fertilized plots	control plots	fertilized plots	
				I	II
1973	*37.69 ± 4.84	*73.71 ± 7.60	—	—	—
1974	29.11 ± 5.00	26.24 ± 4.12	25.55 ± 4.18	20.87 ± 3.09	25.22 ± 3.97
1975	17.30 ± 3.08	11.0 ± 3.15	26.00 ± 3.52	—	37.89 ± 5.60
1979	—	—	23.52 ± 4.03	25.76 ± 3.89	26.67 ± 3.93

*Significant difference, $p < 0.001$.

Species diversity on intensively fertilized plots and on control ones was compared. Values of two indices applied were consistent and allowed to state that fertilizing did not decrease the diversity of spider community. In the first year of experiment there was even a significant increase of diversity in fertilized plots (Table V). In further years the differences between plots were small and variable, statistically insignificant.

Table V. Species diversity indices for fertilized (F) and control (C) plots
A – pitfall traps (spring), B – pitfall traps (season), Q – quadrature method (season)

Index		1972		1973		1974		1975		1976	
		C	F	C	F	C	F	C	F	C	F
Simpson's index	A	0.48	0.62	0.73	0.72					0.47	0.47
Shannon and Weaver's index	B	*1.30	*1.69	1.75	1.72					0.88	0.81
	Q					2.12	2.20	1.03	1.72	1.95	1.91

*Significant difference, $p < 0.001$.

It is worth recording that fertilization which simplified considerably the vegetation composition, reduced the total number of plant species and caused a high dominance of two grass

species only. These two species constituted over 72% of total plant biomass (Traczyk, Traczyk and Pasternak 1976a). But despite the uniformity of plant community the diversity of spider community was not affected.

The spider community responded to fertilizer treatment mainly by changes in the dominance structure.

Species of large spiders (Lycosidae), decrease in number on heavily fertilized plots, whereas the density of smaller species (Linyphiidae) increase.

Differences between plots remained over all years of studies, although fertilized and unfertilized plots were close to one another and there were no barriers for the exchange of animals. Changes in numbers of particular species were quite regular, depending on the size of representatives of a given species. The bigger the individual size the greater the differences in the density in favour of control plots (Table VI). The density of two intermediate species as regards the individual weight was similar (*Pachygnatha degeeri*, *Centromerita bicolor*) on both types of plots. Whereas the density of small-size species (of an average weight of adult individual below 1 mg) was higher on heavily fertilized plots (*Erigone dentipalpis* and *E. atra*) (Table VI). As a result of the described tendency the average weight of spiders on the fertilized plots was smaller than that on the control plots. Differences in the weight of spiders between heavily treated and untreated plots were not high but they were recorded in all years compared. Although statistically significant differences were observed only in the first years of analyses (1974, spring 1975)², afterwards the differences were insignificant. In the eighth year – the last year of experiment – on plots treated with moderate doses (variant I) the mean weight of spiders was even higher than on control plots (Table VII).

Table VI. Density and mean weight of dominant spider species (quadrant method, 1974–1976)

Family	Dominant species	Mean number of individuals · m ⁻²		Mean individual weight of adults mg d. wt
		control plots	fertilized plots (variant II)	
Lycosidae	<i>Trochosa ruricola</i>	0.45	0.0	33.4
	<i>Tarentula pulverulenta</i>	0.87	0.22	16.0
	<i>Pardosa palustris</i>	7.67	3.61	4.8
Tetragnathidae	<i>Pachygnatha degeeri</i>	6.80	6.77	2.1
Linyphiidae s.l.	<i>Centromerita bicolor</i>	2.41	2.93	1.0
	<i>Erigone dentipalpis</i>	0.22	1.80	0.51
	<i>E. atra</i>	0.0	1.58	0.36

The change in locomotory activity of spiders is followed by differences in the dominance structure. The decreasing large-size spider species in fertilized plots were more mobile than small-size species from the family Linyphiidae replacing them.

The ratio of the number of individuals of a given species caught in traps to the density of these species can be treated as an index of locomotory activity (Kaczmarek 1978). Thus

²In first two years spider density was analysed using soil cores, i.e., small samples by means of which fractions of small spiders were almost exclusively caught. Only in the third year of the experiment a full analysis of differences in weight could be made.

measured locomotory activity of lycosid spiders exceeds many times that of linyphiid spiders (Table VIII). As far as the density of more mobile spiders decreases and no significant changes in density occur, the frequency of area penetration by spiders decreases.

Table VII. Mean individual weight of spiders (in mg d. wt)

A – all samples, B – May–June, C – control plots, F – fertilized plots, I – moderate fertilizing, II – heavy fertilizing

Plots	Year from the beginning of the experiment					
	2	3	4	5	8	
	soil cores	quadrate method				
A	C	0.77 ± 0.14	*2.39 ± 0.70	1.27 ± 0.89	1.84 ± 0.69	1.45 ± 0.36
	F I	–	*1.20 ± 0.19	–	–	1.84 ± 0.30
	II	0.53 ± 0.096	0.68 ± 0.15	1.18 ± 0.15	1.70 ± 0.52	1.25 ± 0.25
B	C			*1.65 ± 0.40	1.84 ± 0.69	1.92 ± 0.65
	F II			*0.45 ± 0.08	1.70 ± 0.52	1.06 ± 0.19

*Significant difference, $p < 0.01$.

Table VIII. Index of locomotory activity $\left(\frac{\text{number of individuals} \cdot \text{trap}^{-1} \cdot \text{day}^{-1}}{\text{mean density}} \right)$
of spiders in two types of plots

Family	Species	Control plots	Fertilized plots
Lycosidae	<i>Tarentula pulverulenta</i>	5.45	5.50
	<i>Pardosa palustris</i>	1.08	1.51
Tetragnathidae	<i>Pachygnatha degeeri</i>	0.37	0.75
Linyphiidae s.l.	<i>Erigone dentipalpis</i> + <i>E. atra</i>	0.45	0.36
	<i>Centromerita bicolor</i>	0.39	0.28

In the three years compared the number of spiders caught in pitfall traps on heavily fertilized plots was lower than on control plots. Only in the eighth year a reverse situation was for the first time observed – higher penetration of fertilized plots than that of the control ones. In this last year the highest numbers of spiders were trapped on plots of variant I, moderately treated (on the average 5.6 individuals per trap per day, at values 4.37 in variant 0 and 4.63 in variant II).

Differences between plots were more distinct when analysing the intensity of penetration of the area by dominant species (Fig. 1). In the species structure of the spiders trapped the same tendencies were observed as in the density. More large spiders were trapped in control plots, more small ones in fertilized plots (Fig. 1). In the last year of the experiment the number of small spiders trapped in fertilized plots was higher than the numbers of large spiders trapped in control plots. Thus for the first time higher total spider penetration of fertilized plots than control ones was recorded.

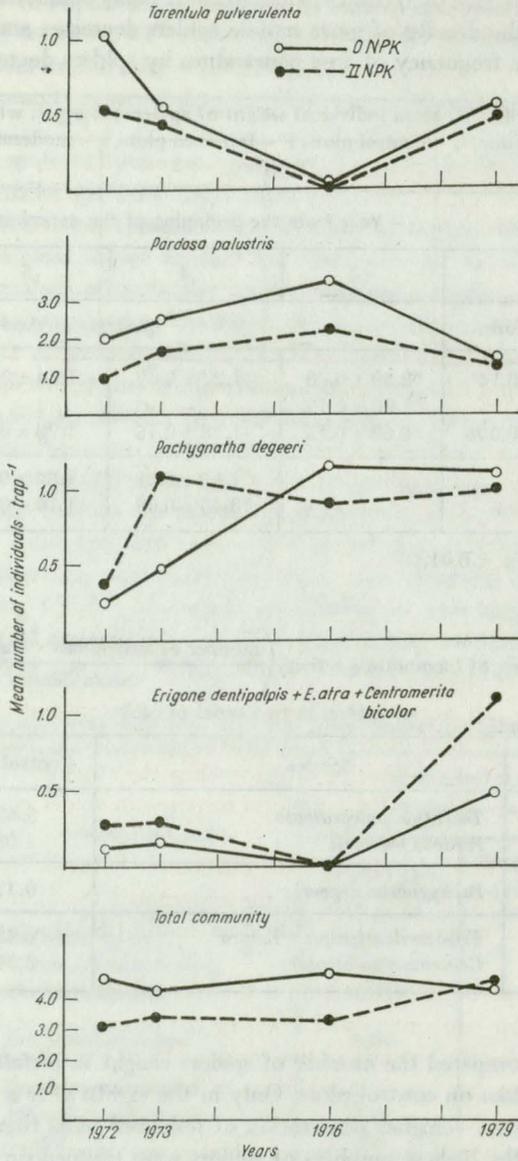


Fig. 1. Changes in the number of spiders caught in pitfall traps on fertilized (II NPK) and control (0 NPK) plots

Statistical analysis of the significance of differences in the number of individuals of particular species caught per trap per day in fertilized and control plots has been made. This analysis allows to assume that in the course of years the differences between plots are becoming less distinct. In the first year of experiment three spider species were caught in significantly different number in control plots, whereas in the next years only the number of one species differed significantly (Table IX).

Table IX. Differences between plots (control and fertilized) in the number of spiders caught in pitfall traps, + more individuals caught on control plots, - more individuals caught on fertilized plots, 0 no individuals caught

Species	Year from the beginning of the experiment:			
	1	2	5	8
<i>Tarentula pulverulenta</i>	+	+	+	+
<i>Pardosa palustris</i>	****	+	***	+
<i>Pachygnatha degeeri</i>	-	-	+	-
<i>Erigone dentipalpis</i> + <i>E. atra</i>	****	-*	0	-*
<i>Centromerita bicolor</i>	-	-	0	0

*Significant difference, $p < 0.05$ **Significant difference, $p < 0.01$. ***Significant difference, $p < 0.001$.

Summing up, the effect of fertilization was a change of dominance structure, i.e., large and mobile spider species decrease in number in fertilized plots and are replaced by smaller, rather sedentary species.

3.2. DURATION OF EXPERIMENT AND THE CHANGES IN PROPORTIONS OF TWO DOMINANT FAMILIES

In an analysis of the influence of fertilizing on the ecosystem not only the short-term response is important, i.e., changes observed immediately after the stimulus, but also, and perhaps first of all, the trend of long-lasting changes when the stimulus is repeated regularly in determined time intervals. What is the long-term response in spider community when the stimulus is repeated during several years?

Considering what has been already said, the differences between fertilized and unfertilized plots were more distinct in the first years of the experiment than later. At first there were higher differences in the mean size of an individual and in the structure of species penetrating the area.

One of the main response to fertilization is the increase of the proportion of the family Linyphiidae in the spider community and lowering the proportion of the family Lycosidae. Thus in order to examine the changes in the community in the course of years the changes in the ratio of these two families - Linyphiidae to Lycosidae (abbrev. Lin and Ly) can be applied.

In the analysed community the family Linyphiidae was dominant as regards density. The density ratio of these two families (Lin/Ly density) was always over 1 and always higher on fertilized plots than on control ones (Table X).

Over the course of years the prevalence of the family Linyphiidae was becoming less distinct. Lin/Ly density ratio decreased. This phenomenon occurred on both plots, but more intensively on the fertilized ones. Thus the differences between the both types of plots decreased. In the third year of experiment the ratio Lin/Ly density, calculated using the quadrat method, was 8 times higher on heavily fertilized plots than on control ones, and in the last year of investigations only twice higher. The same tendency was observed on the basis of soil cores' material (Table X). Thus simultaneously two processes occur: (1) decreasing dominance of Linyphiidae on both types of plots and (2) decreasing differences between plots.

Table X. Linyphiidae/Lycosidae ratio

C – control plots, F – fertilized plots, I – moderate fertilizing, II – heavy fertilizing

Method		Year				
		1972	1973	1974	1975 and 1976	1979
Soil cores	C		3.72	2.27		
	F II		20.50	8.50		
Quadrat method	C			1.50	1.50	1.36
	F I			4.00		1.40
	II			12.20	4.50	3.20
Pitfall traps	C	0.04	0.05		0.57	0.26
	F I					0.35
	II	0.16	0.12		0.54	0.83

The family Lycosidae was dominant in pitfall material. The ratio Li/Ly_{trap} based on this material was always < 1 . Changes occurring within years as regards the structure of species penetrating the area also resulted in more equal contribution of both families, the ratio on both types of plots gradually approximated 1. For example, on control plots, in the first year of the experiment 25 times more lycosid spiders were caught than linyphiids. In the last year of the experiment – only four times more (Table X). Also on heavy fertilized plots, in the first year of the experiment, 6 times more of Lycosidae than Linyphiidae were caught, and in the last year – hardly 1.2 times more.

The decreasing in years differences between plots, so distinct on the basis of Lin/Ly density ratios, were less distinct on the basis of pitfall material. Indices Lin/Ly_{trap} in the first and in the last year of the experiment were similarly higher on fertilized plots than on control ones (Table X).

Thus using the indices of Linyphiidae/Lycosidae it has been found that the whole system, not only the fertilized parts, change within years. This means that proportions of both families are gradually becoming equal and the index tends to approximate 1 on both types of plots. The data indicate also a tendency of decreasing differences between plots with the passage of time in the density of species (Lin/Ly density), whereas the changes in proportions of locomotory active species are less clear (Lin/Ly_{trap}).

4. DISCUSSION

The characteristic increase of the family Linyphiidae contribution after fertilization seems to be a general phenomenon, characteristic not only for this experiment and this meadow, but for many habitats intensively cultivated by man.

Papers presenting the community of arable field spiders mention usually Linyphiidae as a dominant family (Bailey and Chada 1968, Howell and Pieńkowski 1971, Czajka and Goos 1976, Łuczak 1979, F. Müller – unpublished data) not only because of their density, but also because of intensity of penetration, which is rare in other types of ecosystems because of low locomotory activity of these spiders. Thaler, Auserlechner and Mungenast (1977) have compared spiders of the mowed meadow and

cultivated field on the same soils. The contribution of the family Linyphiidae on field is twice greater than on the meadow. Duffey (1975) has compared a new meadow with a 7 years old one. On the old meadow Lycosidae spiders dominate and are scarce on the new meadow, where almost exclusively Linyphiidae occur. Locket (after Łuczak 1979) has treated small species of Linyphiidae (those that dominated on the meadow examined) as a group resistant to agrotechnical treatments.

The direction of changes in spider community in the mown and fertilized meadow are going towards increasing similarity to the spider community of cultivated fields.

Another significant change due to fertilization is diminishing of individuals, and as a result a decrease in the individual average weight. Changes leading in a similar direction, i.e., diminishing of individuals, were observed in that experiment in other groups of predatory arthropods also (Petal 1976, Kajak 1977). In the second year of fertilizing the biomass of such relatively large predators as Carabidae, Formicidae and Chilopoda decreased and that of Staphylinidae (the lightest of the analysed predatory groups) increased.

Simultaneously principal changes took place in the structure of saprophages also affecting the size structure. Thus the biomass of the biggest macrosaprophages – earthworms – decreased; in the first year after fertilization by 9%, in the two next years by 46 and 26% successively (Nowak 1976). In groups of mesosaprophages the biomass either increased after fertilization (Apterygota) or the sometimes considerable decrease in biomass in the first years (Oribatei, Enchytraeidae) was relatively quickly restored. In the third year of the experiment the biomass of Enchytraeidae on fertilized plots was hardly 1.5% lower than on control plots (Makulec 1976) and the biomass of Oribatei exceeded by 34% the biomass on control (Żyromska-Rudzka 1976). Thus changes occurring in the community of saprophages finally resulted in a decrease of the average individual size.

Food composition of epigeic spiders is not well known. Apterygota are considered as the main group of prey both of the family Linyphiidae and Lycosidae (Edgar 1969, Van Wingerden 1975, Nyffeler and Benz 1979). But food preference of these spiders is not known in detail. Though their food spectrum is not known in detail, one thing is certain that such considerable changes in the size structure of saprophages, had to be followed by changes in the size structure of spiders' prey. Changes in the predator community are probably a reaction to these changes in the prey community.

The described above effects of fertilizers could be considered from the point of view of consequences for the ecosystem function. It is clear that a decrease in the size of animals increases their metabolic rate. It is a way of accelerating the mineralization processes, if the total biomass of organisms remains similar. Similar effects are produced by lowering the contribution of predators in the trophic structure of invertebrates. The contribution of predatory arthropods to the total invertebrate biomass decreases after fertilizing (Kajak 1977). As far as epigeic predators can inhibit decomposition processes, by reducing the number of saprophages (Kajak and Jakubczyk 1977), these processes can be stimulated.

But, according to analyses of changes in spider communities in the course of years, the differences between fertilized and unfertilized plots decrease in time. However, they do not return to the state preceding the experiment. The whole system undergoes determined changes of similar direction on both types of plots.

Heavy mineral fertilization causes a very high, four-fold, yield increase (Traczyk, Traczyk and Pasternak 1976a). Only some elements removed with crops are re-

plenished by fertilizers. Thus, after some time a deficit of some elements can be expected. Similar deficit of elements can be also expected in unfertilized plots. This deficit may be responsible for changes in the structure and functioning of consumers (J. Pełal – unpublished data). It is possible that these changes in the content of available elements on both types of plots explain why after some time similar tendencies in spider communities are observed on both types of plots.

5. CONCLUSIONS

As a result of intensive mineral fertilization of the meadow the following takes place:

1. Changes in spider community; large and mobile species of spiders (Lycosidae) are replaced by small more sedentary ones (Linyphiidae s.l.).
2. As a result of these changes the community of grassland spiders resembles the community of spiders in cultivated fields.
3. The community response to fertilizing is most pronounced in the first years of the treatment.
4. The changes observed stimulate the organic matter decomposition.

6. APPENDIX

(List of spider species)³

Dictynidae: (1) *Argenna subnigra* (O. P.-C.); Agelenidae: (2) *Hahnia nava* (Bl.); Lycosidae: (3) *Pardosa agricola* (Th.), (4) *P. monticola* (Cl.), (5) *P. palustris* (L.), (6) *P. prativaga* (L. K.), (7) *P. pullata* (Cl.), (8) *Tarentula cuneata* (Cl.), (9) *T. pulverulenta* (Cl.), (10) *Trochosa ruricola* (D. G.), (11) *T. spinipalpis* (F. O. P.-C.), (12) *Xerolycosa nemoralis* (Westr.); Zoridae: (13) *Zora spinimana* (Sund.); Tetragnathidae: (14) *Tetragnatha extensa* (L.), (15) *Pachygnatha clerckii* (Sund.), (16) *P. degeeri* (Sund.); Linyphiidae: (17) *Bathyphantes gracilis* (Bl.), (18) *Centromerita bicolor* (Bl.), (19) *Centromerus expertus* (O. P.-C.), (20) *C. sylvaticus* (Bl.), (21) *Diplostyla concolor* (Wid.), (22) *Meionetha rurestris* (C. L. K.), (23) *Microlinyphia pusilla* (Sund.), (24) *Stemoryphantes lineatus* (L.); Erigonidae: (25) *Anacotyle stativa* (Sim.), (26) *Araeoncus humilis* (Bl.), (27) *Cnephlocotes obscurus* (Bl.), (28) *Dicymbium nigrum* (Bl.), (29) *Erigone atra* (Bl.), (30) *E. dentipalpis* (Wid.), (31) *Micrargus herbigradus* (Bl.), (32) *Oedothorax fuscus* (Bl.), (33) *O. retusus* (Westr.), (34) *Pelecopis parallellum* (Wid.), (35) *Tiso vagans* (Bl.), (36) *Tapinocyboides pygmaea* (Mge.), (37) *Wideria psilocephala* (Mge.); Theridiidae: (38) *Enoplognatha thoracica* (Hahn.), (39) *Neottiura bimaculata* (L.), (40) *Robertus arundineti* (O. P.-C.), (41) *R. lividus* (Bl.), (42) *Steatoda phalerata* (Panz.); Gnaphosidae: (43) *Haplodrassus signifer* (C. L. K.), (44) *Zelotes electus* (C. L. K.), (45) *Z. pusillus* (C. L. K.); Clubionidae: (46) *Clubiona* sp., (47) *Micaria* sp., (48) *Phrurolithus festivus* (C. L. K.); Thomisidae: (49) *Oxyptila praticola* (C. L. K.), (50) *Xysticus cristatus* (Cl.), (51) *X. kochii* (Th.), (52) *Thanatus formicinus* (Cl.).

7. SUMMARY

The effect of high doses of fertilizers (680 kg NPK · ha⁻¹) was examined by comparing fertilized and unfertilized plots. Differences between plots in the composition of spider community were distinct in the first years of the experiment. Gradually the differences decreased, although the same doses were applied for 8 years. However, the community from fertilized plots did not return to the initial state. On both types of plots the direction of changes was similar, but was more intense on fertilized plots.

³Names and order acc. to Prószyński and Staręga (1971).

Fertilization did not change the total number of spiders (Table IV). It also did not change the species diversity of the community. Diversity indices, of Simpson and Shannon-Weaver, did not differ significantly between both types of plots (Table V), though the plant community was largely simplified after fertilization.

The most significant change was in the species composition of spider community. After the fertilization the numbers of big, mobile species of the family Lycosidae decreased, while the density of small, less mobile spiders of the family Linyphiidae increased (Table VI). Thus the average body weight decreased on fertilized plots (Table VII) as well as the penetration of the area by spiders dropped. The replacement of bigger, more mobile species by smaller and more sedentary ones took place (Table VIII). Changes of the Linyphiidae/Lycosidae ratio were observed. This index increased considerably under the influence of fertilization (Table X). But, in the course of years, on both types of plots the index approximated 1.

On the basis of literature it can be said that such changes of the community – higher number of the family Linyphiidae – occurs usually when man interferes in the ecosystem. Changes in spider community and in the communities of other consumers on meadows stimulate the decomposition rate of organic matter, are one of the mechanisms of this process.

8. POLISH SUMMARY

Wpływ stosowania wysokich dawek nawożenia (680 kg NPK · ha⁻¹) śledzono przez porównanie poletek nawożonych z nie nawożonymi. Różnice między poletkami w składzie zespołu pajaków wystąpiły najwyraźniej w pierwszych latach doświadczenia. Stopniowo różnice zmniejszały się, mimo że w ciągu 8 lat stosowano stale takie same dawki nawozów. Nie oznacza to jednak, że zespół z terenów nawożonych powracał do stanu wyjściowego. Na obu typach poletek zachodziły zmiany zmierzające w podobnym kierunku, ale były bardziej intensywne na poletkach nawożonych.

Nie stwierdzono, aby nawożenie zmieniało ogólną liczebność pajaków (tab. IV). Nie zmniejszało też różnorodności gatunkowej zespołu. Wskaźniki różnorodności – Simpsona i Shannona-Weavera – nie różniły się istotnie na obu typach poletek (tab. V). Nie znalazło tutaj żadnego odzwierciedlenia znaczne uproszczenie się składu roślinności następujące po nawożeniu.

Najistotniejsza była zmiana w układzie gatunków. Po nawożeniu następowało zmniejszenie liczebności ruchliwych gatunków o dużych rozmiarach, należących do rodziny *Lycosidae*, natomiast zwiększenie gęstości mniej ruchliwych drobnych pajaków, należących do rodziny *Linyphiidae* (tab. VI). Konsekwencją tej zmiany było zmniejszenie się przeciętnego ciężaru osobnika na poletkach nawożonych (tab. VII) i zmniejszenie się stopnia penetracji terenu przez pajaki. Nastąpiła wymiana gatunków większych i bardziej ruchliwych na drobniejsze i bardziej osiadłe (tab. VIII). Prześledzono zmiany stosunku liczbowego *Linyphiidae/Lycosidae*. Wskaźnik ten znacznie wzrasta pod wpływem nawożenia (tab. X). Z biegiem lat jednak na obu typach poletek wskaźnik staje się bliższy 1.

Na podstawie literatury wyciągnięto wniosek, że podobna przebudowa zespołu – zwiększenie się znaczenia rodziny *Linyphiidae* – występuje z reguły, gdy nasila się ingerencja człowieka w ekosystemie. Stwierdzone na łąkach zmiany w zespołach pajaków i innych konsumentów sprzyjają przyspieszeniu tempa rozkładu materii, są jednym z mechanizmów, które to przyspieszenie powodują.

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