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PRODUCTIVITY INVESTIGATION OF TWO TYPES OF MEADOWS
IN THE VISTULA VALLEY

IV. SOIL MACROFAUNA

(Ekol. Pol. 19: 129-137). Studies on the abundance and biomass of soil macrofauna were carried out on three meadow sites differing both in the kind of plant material entering the soil and in the rate of its disappearance. Higher numbers and biomass of soil animals occurred on a site with medium rate of organic material disappearance. Along with the lowering in decomposition rate the decrease in mean weight of macrodecomposers was noted.

INTRODUCTION

The purpose of studies was to define numbers and biomass of soil decomposers.

Three meadow sites with different type of management were selected. Two were hay-growing meadows on warp soil - Kazuń I and Kazuń II. The third site - Strzeleckie Meadows - SM - forest surrounded not utilized meadows on a boggy soil. These meadows were described in plant sociological, and pedological respect in previous papers (Traczyk 1971, Czerwiński 1971).

On the study areas organic matter decomposition rate has been evaluated on the basis of weight losses in 5 g rations of grasses following to their 4 weeks long exposure on a meadow. On each occasion 15 grass rations were exposed and collected. Results were converted according to the formula by Wiegert and

Evans (Wiegert, Evans 1964). During the period from May to November of 1968 the decomposition rate for Strzeleckie Meadows amounted to 7.2 mg/g/day, for Kazuń II – to 8.4 mg/g/day, while for Kazuń I – to 13.6 (compare all year data in Jakubczyk 1970).

The quantity of organic matter annually reaching the soil is in Strzeleckie Meadows roughly equal to the primary production and amounts to 317 g/m². On both Kazuń meadows a major portion of green matter is removed in the course of hay-making. About 90 g/m² reaches soil surface. Different rate of organic matter decomposition results in further differentiation of these meadows. Strzeleckie Meadows provide an environment in which plant fall forms a thick layer throughout the year, at Kazuń II there is slight quantity of fall to be found on soil surface, while at Kazuń I in the middle of vegetation season the dead matter practically disappears entirely from the soil surface. Food resources for decomposers are in harvested Kazuń meadows supplemented by root production (higher one than on Strzeleckie Meadows). Thus the environments discussed differ from each other mainly in the kind of plant material reaching the soil. On Strzeleckie Meadows above ground parts prevail, while at Kazuń – plant roots.

METHODS

The abundance of soil macrofauna in the areas discussed has been estimated during the 1968 vegetation season (May-November). Twenty soil samples with the area of 100 cm² and depth of 15 cm have been taken on each site at 2–3 week intervals. Animals were collected by hand. Thus, the composition of a group discussed as macrofauna included, apart from earthworms and insect larvae, also *Enchytraeidae*. The number of 20 samples enabled the estimation of mean abundance of most soil animals with ca 10% standard error. The depth of 15 cm was sufficient to include 78% of the number of animals inhabiting humus horizon.

Numbers of epigeic decomposers had been estimated indirectly with the aid of data from pitfall traps.

The biomass of soil animals was calculated according to the relationship found:

$$\text{dry weight of animal} = \frac{25 \times \text{weight of animal preserved in alcohol}}{68}$$

The conversion was obtained on the basis of a comparison of the relationship between wet and dry weight of earthworms freshly collected in field (50 specimens) and between wet and dry weight of earthworms kept in 75% alcohol (20 specimens per month during 6 months).

RESULTS

The discussed community of macrodecomposers consists of the following groups of animals:

The first link of decomposers chain represented in meadows by isopods and few millipeds.

The second group of soil humificators represented by earthworms, insect larvae (among which *Diptera* larvae were most numerous), and finally enchytreids classified also here.

Density and biomass of soil fauna in three meadow sites

Tab. I

Group	Density/m ²						Biomass g. dry weight/m ²					
	SM		K II		KI		SM		K II		KI	
	N	%	N	%	N	%	N	%	N	%	N	%
<i>Lumbricidae</i>	97	33	225	68	82	48	5.3	84	11.9	91	7.0	92
<i>Enchytraeidae</i>	137	41	48	15	45	27	0.1	2	0.3	3	0.1	1
Insect larvae	78	26	59	17	43	25	0.9	14	0.8	6	0.5	7
Total	312	100	332	100	170	100	6.3	100	13.0	100	7.6	100

Highest numbers of animals were recorded in Kazuń II – 332 animals/m², quite similar number – on Strzeleckie Meadows – 312, and the lowest one – in Kazuń I – 170 (Tab. I). In two Kazuń habitats earthworms were the quantitative dominants, only in Strzeleckie Meadows – enchytreids prevailed in numbers. The quantitative substitution is after all characteristic for these two groups – enchytreids have the highest percentual proportion in habitats with a low proportion of earthworms. This proportion decreases with the increase in earthworm numbers. Numbers of insect larvae in relation to the general number of soil animals decreased from Strzeleckie Meadows (mainly *Diptera* larvae) through Kazuń I (mainly *Curculionidae* larvae) to Kazuń II where insect larvae comprise the lowest percentage (Tab. I). The small number of insect larvae in the discussed material and different degree of the accuracy of identification (in general to family, sometimes to genera) entitle to only provisional conclusions. It seems, however, that the meadow Kazuń I is considerably less differentiated in respect to specific composition than the remaining habitats (Tab. II). The meadow in Kazuń II is in faunistic respect more similar to Strzeleckie Meadows than to Kazuń I which is close in phytosociological and soil respects. This is indicated by the fact of the absence in Kazuń I of such, common for the two remaining meadows, families, as *Driopidae*, *Tabanidae*, *Bibionidae*. On the other hand the occurrence of *Curculionidae* larvae is common for the two Kazuń meadows. Numbers of the latter group, similarly as numbers

Occurrence of insect larvae in soil, of three meadow habitat*

Tab. II

Group	Density/m ²		
	SM	K II	K I
Larvae predominantly predacious	22.6 (29%)	35.7 (61%)	6.0 (14%)
<i>Elateridae</i>			
<i>Athous niger</i>	-	-	+
<i>Actenicerus sielandicus</i>	11.1	23.8	-
<i>Carabidae</i>	2.1	2.3	1.3
<i>Staphylinidae</i>	3.1	3.7	1.5
<i>Cantharidae</i>	0.7	+	2.5
<i>Coccinellidae</i>	-	+	-
<i>Diptera</i>			
<i>Tabanidae</i>	5.6	4.1	-
<i>Asilidae</i>	-	0.9	-
Larvae predominantly phytophagous	4.9 (6%)	16.7 (28%)	31.2 (73%)
<i>Elateridae</i>			
<i>Agriotes</i> sp.	+	4.1	10.1
<i>Curculionidae</i>	-	5.5	16.6
<i>Chrysomelidae</i>	+	-	-
<i>Diptera</i>			
<i>Cecidiomyidae</i>	+	-	-
<i>Anthomyidae</i>	0.7	0.7	-
<i>Lepidoptera</i>	3.1	6.4	4.5
Larvae predominantly saprophagous	50.3 (65%)	6.2 (11%)	5.4 (13%)
<i>Tenebrionidae</i>	0.7	-	-
<i>Driopidae</i>	2.7	+	-
<i>Diptera</i>			
<i>Bibionidae</i>	39.9	1.1	-
<i>Tipulidae</i>	4.1	1.4	1.1
<i>Dolichopodidae</i>	1.7	2.3	1.5
<i>Ceratopogonidae</i>	+	+	-
<i>Syrphidae</i>	0.7	+	-
<i>Muscidae</i>	+	+	-
<i>Clusiidae</i>	-	-	2.2
Number of groups	18	18	11

*For numerous groups, particularly for *Diptera* larvae with clumpy distribution the density estimate is probably burdened with serious error.

of all soil phytophags, increased in the sequence: Strzeleckie Meadows, Kazuń II, and Kazuń I. This is probably connected with greater amount of roots in Kazuń habitats.

Activity of epigeic saprophags (number per trap per day)

Tab. III

Group	SM	K II	K I
<i>Isopoda</i>	1.860	1.594	0.165
<i>Diplopoda</i>	0.012	0.006	0.011
<i>Lumbricidae</i>	0.027	0.018	0.003
Other	0.012	0.001	0.004
Total	1.911	1.619	0.183

More important species of *Lumbricidae* in meadow habitats studied

Tab. IV

Species	Length cm	Abundance %		
		SM	K II	K I
<i>D. octaedra</i> (Sav.)	2-4	30.9	12.6	11.0
<i>E. tetraedra</i> (Sav.)	2-6	7.5	12.6	3.9
<i>A. rosea</i> (Sav.)	2.5-8.5	22.4	8.6	23.4
<i>A. caliginosa</i> (Sav.)	4-7	13.0	49.0	42.9
<i>O. lacteum</i> (Oyerley)	3-16	6.0	6.0	2.6

Abundance of epigeic decomposers, and also their activity, are lowest in Kazuń I and highest in Strzeleckie Meadows (Tab. III). This concerns mainly the occurrence of the dominant group – *Isopoda* (represented almost exclusively by the species *Tracheoniscus rathkei* Brandt). The penetration of litter by earthworms alters similarly. Different intensity of litter penetration results from different relations in the domination of earthworm species (Tab. IV). Surface inhabiting species – *Dendroboena octaedra* Sav. comprised in Strzeleckie Meadows 31% of the whole earthworm population, while in the two remaining habitats occurs less numerously: Kazuń II – 13%, Kazuń – 11%. When the genus *Lumbricus*, not divided into species, will be classified to the surface group, then the total number of these species will increase also in sequence – Kazuń I, Kazuń II, Strzeleckie Meadows. Therefore, the increase in plant fall accumulation is accompanied by an increase in the abundance of litter inhabiting species.

Habitats characterized by a great accumulation of the fall of above ground parts of plants have a similar dynamics of earthworm numbers (Fig. 1). In mid-summer on meadows Kazuń II and Strzeleckie occurs an obvious increase in numbers. Such course of abundance is characteristic both for the surface species *Dendroboena octaedra* Sav. and for the species inhabiting greater depth (down to 30 cm)

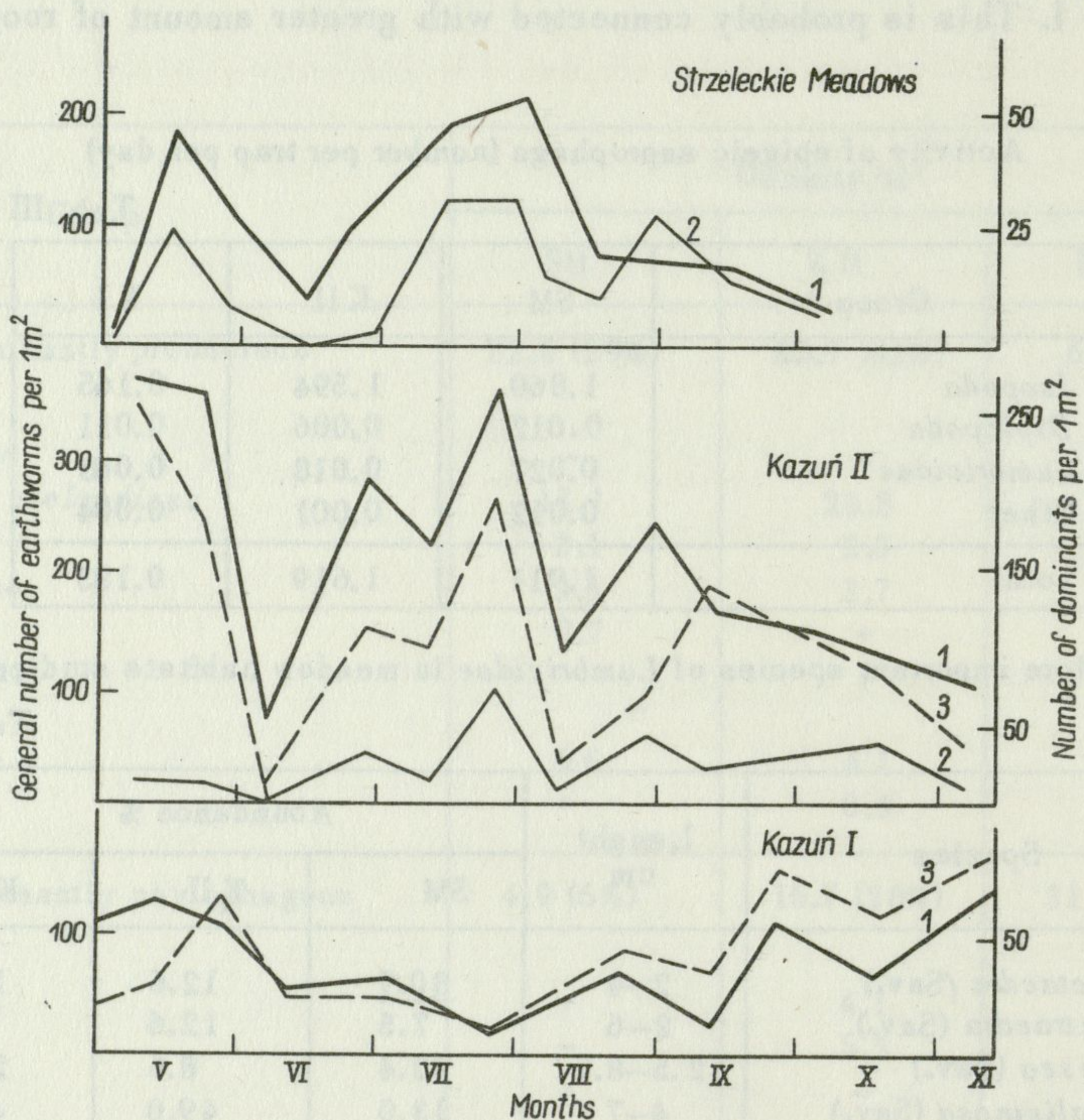


Fig. 1. Changes in the *Lumbricidae* density in three habitats

1 - general numbers of earthworms, 2 - numbers of *Dendroboena octaedra*, 3 - numbers of *Allolobophora caliginosa*

- *Allolobophora caliginosa* Sav. A distinct decrease in earthworm numbers during summer was recorded in Kazuń I. The course of numbers may result both from the attractiveness of plant fall and from a strong influence of drought upon earthworms in the driest site among those discussed, in Kazuń I.

The mean status of the biomass of soil animals has a slightly different course than the mean level of their abundance (Tab. I). The general biomass of soil animals amounts in Strzeleckie Meadows to 6.3, in Kazuń II - to 13, while in Kazuń I - to 7.6 g dry matter per m². In all sites earthworms dominate in the biomass, their percentual proportion increasing from 84% in Strzeleckie Meadows to 92% in Kazuń I.

The weight of average individual in different sites was calculated from the ratio between numbers and biomass of animals. In Strzeleckie Meadows is amounted to 28 mg of dry matter, in Kazuń II - to 38 mg, in Kazuń I - to 48 mg. Thus, the increase in average individual weight is parallel to the increased rate of plant fall decomposition. Habitats with a rapid decomposition - in this case Kazuń I - are characterized by the occurrence of large animals,

in moist habitats with slower decay – as Strzeleckie Meadows – the accumulation of dead plant material is accompanied by the occurrence of small animals.

In the environments described this rule is maintained through:

1. The substitution of whole groups. While turning from Strzeleckie Meadows to Kazuń I the quantity of *Enchytraeidae* decreases, while the quantity of earthworms performing the similar role, but greater ones – increases (Tab. I).

2. Changes in domination from small to bigger species. In Strzeleckie Meadows the small *D. octaedra* is dominant among earthworms, while in Kazuń meadows by twice as large *A. caliginosa* prevails. Besides, in Kazuń I the percentual proportion of large earthworm species is the highest (Tab. IV).

3. Changes in size within the same species. Judging from the distribution of size classes (Fig. 2) *A. caliginosa* attains the smaller size and therefore is probably more reduced in Kazuń II than in Kazuń I.

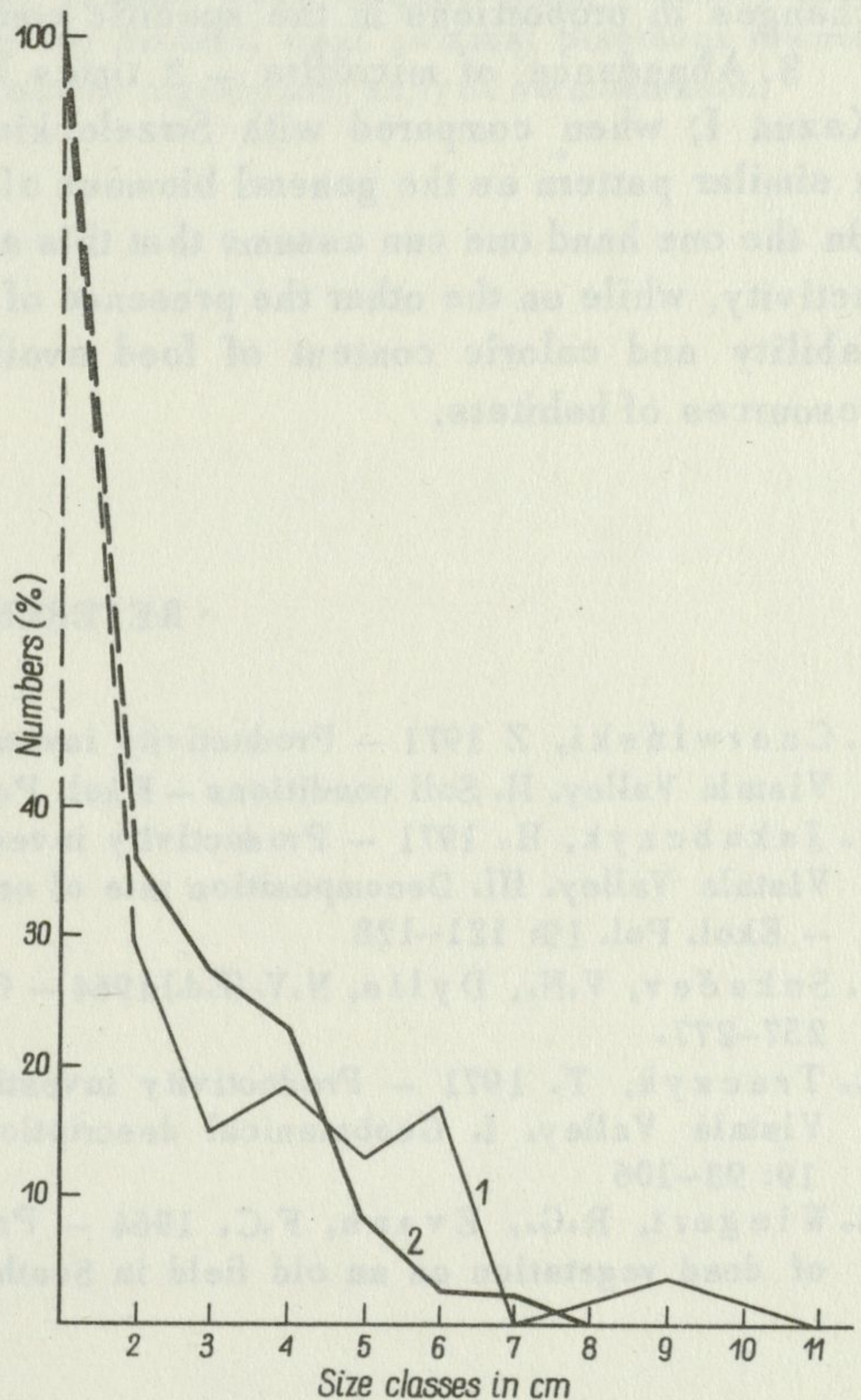


Fig. 2. Reduction in *A. caliginosa* numbers in two meadow sites
1 – Kazuń I, 2 – Kazuń II

RECAPITULATION

1. Abundance and group composition of soil decomposers does not probably result from food resources in habitat. This is evidenced by different numbers of soil animals in two meadows in Kazuń – very similar in their primary production. The domination of individual groups and thus the “efficiency” of action of the whole decomposers system in the rate of dead matter disappearance depends upon climatic factors (mainly moisture), but first of all upon the kind food flow (green parts of plants or roots).

2. While considering the size of macrofauna biomass one can note that the environment with slow decomposition rate leading to the formation of boggy soil

(Strzeleckie Meadows) is characterized by the occurrence of smaller animals than environments with rapid decomposition (KI, KII). The rule: big animals – rapid rate of decomposition is realized in general through changes in proportions between macrofauna and mesofauna (literature review by Sukačev, Dylis 1964). In the environments discussed this rule is realized through changes in proportions in the specific composition of macrodecomposers group.

3. Abundance of microflora – 3 times higher in Kazuń II and 2.5 times in Kazuń I; when compared with Strzeleckie Meadows (Jakubczyk 1971) has a similar pattern as the general biomass of soil macrofauna in these environments. On the one hand one can assume that this abundance is stimulated by macrofauna activity, while on the other the presence of microorganisms increases the assimilability and caloric content of food available to animals, and thus the food resources of habitats.

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BADANIA PRODUKTYWNOŚCI DWÓCH TYPÓW ŁĄK W DOLINIE WISŁY

IV. MAKROFAUNA GLEBOWA

Streszczenie

Badania prowadzono na trzech stanowiskach łąkowych – na łące naturalnej – SM i na dwu łąkach kośnych – KI i KII. Liczebność makrofauny glebowej oceniana była na podstawie prób ilościowych o wielkości $100\text{ cm}^2 \times 15\text{ cm}$. Suchą masę otrzymywano przez pomnożenie wagi zwierząt przetrzymywanych w alkoholu przez stosunek wagi alkoholowej do świeżej i zawartość wody w ciele zwierząt.

Największa liczebność i biomasa makrofauny była na jednej z łąk kośnych – KII. Bagienną łąkę naturalną SM charakteryzowała dość wysoka liczebność zwierząt i stosun-

kowo niska ich biomasa (Tab. I). Jak wynika z zestawienia danych dotyczących liczebności i biomasy – najwyższą średnią wagę mają zwierzęta glebowe na stanowisku KI, najniższą kolejno w KII i SM. To zmniejszanie się średniej wagi widoczne jest w zmianie dominacji ilościowej całych grup (w SM dominują *Enchytraeidae*, w KI i KII – *Lumbricidae*). Zmienia się także dominacja w obrębie gatunków – z niewielkich (*D. octaedra* na stanowisku SM) na dużo większe (*A. caliginosa* na stanowiskach KI i KII). Wreszcie nawet osobniki tego samego gatunku mogą osiągać różne rozmiary zależnie od stanowiska (Fig. 2). Zmniejszanie się średniej wagi zwierząt przebiega równolegle ze zmniejszaniem się tempa rozkładu materii organicznej na tych stanowiskach.

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