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THE RELATIONSHIP BETWEEN THE DIVERSITY OF SOIL NEMATODE COMMUNITIES AND THE PLANT SPECIES RICHNESS OF MEADOWS

ABSTRACT: Research was carried out on two ley meadows and one permanent meadow situated in north-eastern Poland and belonging to the order Arrhenatheretalia. The meadows differed in the diversity of the vegetation cover, which was a function of age (1–3 years, 8–10 years and 20 years). The older meadows differed from the youngest in having a lower proportion of Rhabditida and higher of Tylenchida, as well as in the increased density of fungivores and phytophages, the reduced dominance of particular genera and higher values for diversity indices. The maturity index (MI) for the non-parasitic fau-

na was highest on the permanent meadow and lowest on the many-year-old meadow, while the plant parasite index (PPI) was lowest on the permanent meadow. It may be concluded that the plant species richness of the sward – increasing with age – exerts a decisive and differentiated influence on the structure of the communities of nematodes as described by diversity indices and in terms of their functional groups.

KEY WORDS: soil nematodes, diversity indices, maturity indices, meadow age, trophic groups.

1. INTRODUCTION

The effects of the changing species richness of animals cannot be researched independently of plant species richness (Lawton 1994).

The intensification of measures taken in the environment leads not only to reduced plant diversity, but also to reduced diversity among animals and the microflora (Swift and Anderson

1993). Among such measures is the ploughing used on ley meadows, which are most often sown with a single species of grass. Many years of use of such a meadow permit secondary vegetational succession to proceed and ensure that an influence is exerted on soil organisms and the processes of decomposition. Research confirms the significant role of the soil

fauna in ecosystem processes (Huhta and Setälä 1990, Kaczmarek et al. 1995).

Nematodes are represented at all trophic levels of consumers and decomposers. As such, these animals are linked with – and provide a reflection of – such fundamental ecological processes in soil as decomposition and mineralization, as well as having an influence on primary production. It is already known that lower diversity in the communities of soil nematodes of single-year or monocultural cultivation may be set against the significantly higher diversity of multi-year or permanent cultivation (Ferris and Ferris 1974, Wasilewska 1979, Freckman and Ettema 1993) – although examples of the lack of such a relation-

ship have also been provided (Sohlenius et al. 1987).

The aim of the work described here was to determine the influence of a diversified vegetational environment on the variables describing a community of nematodes.

Analysis considered the changes in communities of soil nematodes that were dependent on the diversity of the vegetation cover of meadows, which was in turn a function of meadow age. Specifically, it was the taxonomic and trophic structure of the soil nematodes that was considered, along with the relationships between trophic groups and the populations of different genera. Such indices as a diversity index, a trophic diversity index and a maturity index were applied in the cases of the meadows differing in age.

2. SITE DESCRIPTION

The meadows studied are in north-east Poland, within Suwałki Landscape Park. Environmental data for this area have been given by Kajak (1997), Jankowski (1997a, b) and Kusińska and Łakomic (1997). The meadows here most often cover 1–4 ha and are included within the normal rotational cycle in which the use of meadows lasts 5–10 years. However, areas that are harder to cultivate have permanent meadows and pasture. Mineral fertilizer is applied to the meadows at c. 175 kg NPK ha⁻¹, and mowing is followed by the autumn of grazing of cattle on them.

The study area is dominated by typical brown soils derived from medium sands. The pH of the upper layer is in the range 5.8 to 6.4. Of the three meadows, two are leys adjoining one another: the 1–3-year-old meadow (LA) and the 8–10-year-old meadow (LC). The third – about

1 km from the other two – is a "permanent" meadow (P). All are fresh meadows of the order Arrhenatheretalia. The youngest (LA) was sown with *Dactylis glomerata* L. and is still in the first, open community phase, while the permanent meadow (P) has vegetation of the *Anthylli-Trifolietum* association in a closed-phase community (with 100% cover). The many-year-old meadow (LC) is in the nature of an intermediate site (Jankowski 1997b).

Thus the ages of the meadows determine the species richness of their vegetation, the biomass of the cover and the layer structure of the sward (Table 1). The community of the permanent meadow (P) was characterised by the greatest species richness and the highest biomass. The mass of litter was particularly noteworthy, being four times greater

Table 1. Characteristics of vegetation and soil carbon contents of meadows after Kusińska and Łakomic 1997, Jankowski 1997b and Szanser 1997. LA – 1–3-year-old meadow, LC – 8–10-year-old meadow, P – permanent meadow.

Characteristic	Site (age of meadow in years)		
	LA (1–3)	LC (8–10)	P (>20)
Syntaxonomic classification	<i>Dactylis glomerata</i> L. community	Community of the alliance Arrhenatherion	<i>Anthylli-Trifolietum</i> association
Number of species	4	31	35
Number of dominant species	2	18	24
Biomass g dry wt m ⁻²			
above-ground	320	344	385
litter	60	197	233
below-ground	875	850	950
Number of layers in sward	2	3	3
C content (% dry wt)	1.1	1.9	2.7

than on the newly-established meadow (LA).

An extended period of use of a meadow favours the accumulation of all humus fractions in the soil (Kusińska

and Łakomic 1997). The carbon content of the soil of meadow LC is 1.7 times greater than on LA, while that of meadow P is 2.5 times greater (Table 1).

3. METHODS

The meadow communities have been characterised by the method of phytosociological records after Braun-Blanquet (Jankowski 1997b), with biomass being assessed by weighing (Jankowski 1997b, Szanser 1997). Humus was determined using a modified version of Tiurin's Method (Kusińska and Łakomic 1997).

Soils samples to obtain nematodes were taken at random from 20 points with a soil corer (opening surface 2 cm²) to depths of 25 cm. The soil obtained was mixed and used to provide 3 subsamples of 25 cm³ each. Nematodes were extracted using a modified version of Baermann's method (Wasilewska 1979). The nematodes obtained from each sub-

sample were identified to the level of the genus (where possible) and classified by trophic group (Wasilewska 1971). This allowed for the determination of the following variables describing nematode communities:

- the density of the grouping as a whole, of trophic groups and of genera,
- the relationships between the functional groups:

B/F – the ratio of the number of bacterivores to fungivores (justified as an evaluation of the dominant decomposition (via bacteria or fungi));

B/F+FPP – as above, but with account taken of facultative plant parasites being partially fungivorous;

B+F/OPP – the ratio of the number of bacterivores and fungivores to obligate plant parasites (justified as an evaluation of the prevalent form of mineralisation: from dead plant tissue (via bacteria and fungi) or from living tissue;

– the total number of genera in the study period (genus richness) and the mean number of genera per sample;

– a Shannon index for generic diversity H' (Pielou 1975)

– the maturity index for nematodes (MI), as proposed by Bongers (1990); for all nematode genera except plant parasites.

$$MI = \sum_{i=1}^n v(i) p(i),$$

where $v(i)$ is the coloniser-persister value of the i -th genus, using c-p values 1–5; and where $p(i)$ is the proportion of the i -th genus. The index reflects the perceived r-K strategy gradient among nematodes: lower values relate to earlier successional stages or environmental deg-

radation, higher ones to advanced stages of succession or a return to balance;

– the Plant Parasite Index, PPI, was determined in a similar manner for plant-pathogenic genera only (Bongers 1990). Scale c-p values vary between 2 and 5, with higher values for the index reflecting greater vegetational production;

– a trophic diversity index – T (Heip et al. after Freckman and Ettema 1993);

$$T = 1/\sum p(i)^2,$$

where $p(i)$ is the proportion of the i -th trophic group in the nematode community. The index describes the differentiation of ecological (functional) groups in the community.

The t-Student test was used to determine the statistical significance of differences, while differences between H' values were assessed with the aid of parametric significance tests (Poole 1974).

Samples were taken on 27.06.1988, 09.08.1989 and 19.06.1990 on meadows LA and LC, as well as twice (in 1989 and 1990) on meadow P.

4. RESULTS

4.1. COMPOSITION AND STRUCTURE OF TAXA

From the systematic point of view, the nematodes of the studied sites belonged to 6 orders and 21–24 families (Table 2). 74–87% of the grouping were members of the Rhabditida and Tylenchida. Older meadows were characterised by significantly greater shares of the latter group (mainly at the expense of the former), in spite of the fact that the absolute densities of representatives of the two orders were considerably greater (Table 2).

From the point of view of the number of genera, the richest site was

meadow LC (with 43), followed by both LA and P with 33 (Table 3). Only a few genera showed statistically significant differences in their densities: *Tylenchorhynchus* and *Aphelenchus* were more abundant on LC than on LA, while *Ditylenchus*, *Filenchus*, *Paratylenchus* and *Aphelenchus* were more abundant on P than on LA. LC and P differed significantly when it came to 8 genera, with *Paratylenchus*, *Tylencholaimus*, *Mesodorylaimus*, *Heterocephalobus* and *Aglenchus* being commoner on P, and *Eudorylaimus*, *Tylenchorhynchus* and

Table 2. Taxonomic structure and abundance (N) of nematode communities on variously-aged meadows. LA – 1–3-year-old meadow, LC – 8–10-year-old meadow, P – permanent meadow. Other characteristics as in Table 1

Order*	Site					
	LA		LC		P	
	N 10 ³ m ⁻²	%	N 10 ³ m ⁻²	%	N 10 ³ m ⁻²	%
Araeolaimida	217	7	566	8	200	4
Dorylaimida	484	16	635	9	425	8
Enoplida	67	2	100	1	75	1
Monhysterida	17	1	67	1		
Rhabditida	1401	47	2201	30	2000	38
Tylenchida	783	26	3784	51	2575	49
Number of families	21		24		23	

* Orders and families mainly distinguished according to Andr assy 1976.

Table 3. Mean density (10³ m⁻²) of nematode genera in the study period on variously-aged meadows. LA – 1–3-year-old meadow, LC – 8–10-year-old meadow, P – permanent meadow; TC – trophic classification, B – bacterivores, F – fungivores, FPP – facultative plant parasites, OPP – obligate plant parasites, O – omnivores, P – predators; c-p – colonizers-persisters value; n – number of samples

Genus	Site			TC	c-p
	LA n = 9	LC n = 9	P n = 6		
1. <i>Rhabditis</i> s.l.	500	617	300	B	1
2. <i>Acrobeloides</i>	467	300	875	B	2
3. <i>Eudorylaimus</i> s.l.	317	417 ²⁾ *	200	O	4
4. <i>Panagrolaimus</i>	200	867	50	B	1
5. <i>Tylenchorhynchus</i>	183 ¹⁾ **	783 ²⁾ *	225	OPP	3
6. <i>Aphelenchoidea</i>	133	767	300	F	2
7. <i>Plectus</i>	117	233	150	B	2
8. <i>Acrobeles</i>	117	83		B	2
9. <i>Ditylenchus</i>	100	100	75	FPP	2
10. <i>Pratylenchus</i>	83	33 ²⁾ **	250 ³⁾ *	OPP	3
11. <i>Wilsonema</i>	83	50		B	2
12. <i>Tylenchus</i>	67	317	100	FPP	2
13. <i>Prismatolaimus</i>	50	83	75	B	3
14. <i>Filenchus</i>	50	117	200 ³⁾ **	FPP	2
15. <i>Paratylenchus</i>	50	83 ²⁾ *	450 ³⁾ *	OPP	2
16. <i>Eucephalobus</i>	50	67	50	B	2
17. <i>Aphelenchus</i>	50 ¹⁾ **	800 ²⁾ **	125 ³⁾ *	F	2

Table 3. continued

	Genus	Site			TC	c-p
		LA n = 9	LC n = 9	P n = 6		
18.	<i>Coslenchus</i>	33	83	100	FPP	2
19.	<i>Chiloplacus</i>	33	17		B	2
20.	<i>Tylencholaimus</i>	33	17 ²⁾ *	75	O	4
21.	<i>Dorylaimida</i> others	33	17		O	4
22.	<i>Mesodorylaimus</i>	33	17 ²⁾ *	75	O	5
23.	<i>Cephalobus</i>	17	117	25	B	2
24.	<i>Cervidellus</i>	17	50	25	B	2
25.	<i>Oxydirus</i>	17			O	5
26.	<i>Cylindrolaimus</i>	17	33		B	3
27.	<i>Alaimus</i>	17			B	4
28.	<i>Paraphelenchus</i>	17	200		F	2
29.	<i>Boleodorus</i>	17	67	50	F	2
30.	<i>Pungentus</i>	17		25	O	4
31.	<i>Diphtherophora</i>	17	50		O	3
32.	<i>Aporcelaimellus</i>	17	17	50	O	5
33.	<i>Monhystera</i>	17	67		B	1
34.	<i>Gracilacus</i>		200	250	OPP	2
35.	<i>Rhabdolaimus</i>		200	50	B	3
36.	<i>Helicotylenchus</i>		183		OPP	3
37.	<i>Heterocephalobus</i>		50 ²⁾ ***	600	B	2
38.	<i>Anaplectus</i>		50		B	2
39.	<i>Actinolaimus</i>		50		P	5
40.	<i>Teratocephalus</i>		33	25	B	3
41.	<i>Mononchus</i>		33		P	4
42.	<i>Odontolaimus</i>		17		O	3
43.	<i>Aglenchus</i>		17 ²⁾ ***	350	FPP	2
44.	<i>Pseudhalenchus</i>		17		F	2
45.	<i>Basiria</i>		17		FPP	2
46.	<i>Leptonchidae</i> others		17		O	4
47.	<i>Nothotylenchus</i>			50	F	2
48.	<i>Seinura</i>			25	P	2
49.	<i>Drilocephalobus</i>			25	B	2
50.	<i>Diplogaster</i>			25	B	1
51.	<i>Paurodontus</i>			25	F	2

Statistically significant differences: ¹⁾ LA and LC, ²⁾ LC and P, ³⁾ P and LA; * p = 0.05, ** p = 0.01, *** p = 0.001.

Table 4. Composition of dominant nematode genera (constituted 57–59% of the total community) with an indication of their trophic classification (TC). B – bacterivores, F – fungivores, FPP – facultative plant parasites, OPP – obligate plant parasites, O – omnivores, P – predators; More explanations in Table 3.

LA			Site LC			P		
Nematode genus	%	TC	Nematode genus	%	TC	Nematode genus	%	TC
<i>Rhabditis</i> s.l.	17	B	<i>Panagrolaimus</i>	12	B	<i>Acrobeloides</i>	16	B
<i>Acrobeloides</i>	16	B	<i>Aphelenchus</i>	11	F	<i>Heterocephalobus</i>	11	B
<i>Eudorylaimus</i>	11	O	<i>Tylenchorhynchus</i>	11	OPP	<i>Paratylenchus</i>	8	OPP
<i>Panagrolaimus</i>	7	B	<i>Aphelenchoides</i>	10	F	<i>Aglenchus</i>	7	FPP
<i>Tylenchorhynchus</i>	6	OPP	<i>Rhabditis</i> s.l.	8	B	<i>Rhabditis</i> s.l.	6	B
			<i>Eudorylaimus</i>	6	O	<i>Aphelenchoides</i>	6	F
						<i>Pratylenchus</i>	5	OPP
Total	57			58			59	

Aphelenchus on LC (Table 3). 22 genera were common to all three meadows (Table 3).

Taken to determine the degree of dominance was the number of the best-represented genera accounting together for 57–59% of the grouping on a given meadow. The value was 5 for meadow LA, 6 for LC and 7 for P (Table 4). Thus the degree of dominance would appear to

decrease with meadow age. Among the dominants only *Rhabditis* s.l. (a bacterivores) occurred on all three meadows, while 4 genera were found on two and 6 on only one (Table 4). Thus the meadows differed in the diversity of the genera in the group of dominants. On LA the dominants were representatives of three trophic groups, while on LC and P they were representatives of four (Table 4).

4.2. TROPHIC STRUCTURE

In the study period, the average densities of nematodes were between 3 and $7.3 \times 10^6 \text{ m}^{-2}$. There were no significant differences in density between the three meadows or between the groups of bacterivores, omnivores and predators (Table 5).

However, the three remaining groups did show statistically significant differences in density. Fungivores were 2.5 to 8.5 times more abundant on LC and P meadow than on LA, while facultative plant parasites were 2.6 to 3.3 times more abundant and obligate plant parasites 3.7 to 4.1 times more abundant (Table 5).

Bacterivores made up a greater percentage of all nematodes on LA than on LC and P. Together with fungivores (B+F), they constitute about 65% of the total on LA and LC and only 53% of the total on P. Thus the greater part of the nematode community of the youngest meadow (LA) and the many-year-old meadow (LC) was linked with the decomposition of dead organic matter, while the percentage was lower on P.

The ratio of bacterivore to fungivore abundance (B/F) was even several times higher on LA than on the other meadows

Table 5. Density ($N \cdot 10^3 \cdot m^{-2} \pm SE$) and relative abundance (%) of trophic groups in nematode communities on variously-aged meadows. TC – trophic classification, B – bacterivores, F – fungivores, FPP – facultative plant parasites, OPP – obligate plant parasites, O – omnivores, P – predators; (bold print illustrates numerical prevalence). More explanations in Table 3.

Parameter	Site					
	LA n = 9		LC n = 9		P n = 6	
	N	%	N	%	N	%
B	1702 \pm 693	58	2917 \pm 1369	40	2275 \pm 1475	43
F	217 \pm 116	7	1851 \pm 725*	25	550 \pm 300*	10
FPP	250 \pm 132	8	651 \pm 76*	9	825 \pm 125*	16
OPP	316 \pm 116	11	1282 \pm 337*	17	1175 \pm 425*	22
O	484 \pm 145	16	569 \pm 148	8	425 \pm 25	8
P	0	0	83 \pm 83	1	25 \pm 25	1
Total	2969 \pm 1168	100	7353 \pm 2430	100	5275 \pm 2075	100
B/F	7.8		1.6		4.1	
B/F + FPP	3.6		1.2		1.6	
B + F/OPP	6.1		3.7		2.4	

* $p < 0.05$ for LA and LC, LA and P.

as was the ratio of bacterivores to fungivores + facultative plant parasites (feeding also upon fungal hyphae) (B/F + FPP) (Table 5). This suggests that decomposition on the youngest meadow is mainly mediated by bacteria, while on the older meadows the participation of fungi in decomposition is greater.

The other ratio between two functional groups (B + F/OPP) seems equally valuable in distinguishing the meadows of different ages. When LA is compared with LC and P, there is a prevalence of the decomposition of dead organic matter over rapid mineralisation at the expense of living plant tissue (Table 5).

4.3. DIVERSITY AND MATURITY

Meadows LA and P had the same total number of genera in the study period. However, the mean number of genera per sample was distinctly lower at the former site (Table 6). This may attest to great periodic variability in the composition of the community on meadow LA. Similarly the Shannon Index for generic diversity was significantly higher on the two older meadows. The range of values for the index in the study period was widest for

LA – confirming the aforementioned periodic variability in taxonomic composition.

The trophic diversity index (T) was significantly higher on the two older meadows (Table 6).

The maturity index for the community (MI) was indeed highest on P (attesting to the most advanced stage of secondary succession within the nematode community). However the value was

Table 6. Biocoenotic indices describing the nematode communities on age-differing meadows (mean values given with ranges in brackets). Genus richness is the total number of genera recorded in the period 1988–1990. Bold print illustrates numerical prevalence. LA – 1–3-year-old meadow, LC – 8–10-year-old meadow, P – permanent meadow

Index	Site		
	LA n = 9	LC n = 9	P n = 6
Genus richness	33	43	33
Number of genera <i>per</i> sample	17.6 (12–23)	28.3 (24–31)	25.0 (22–31)
Shannon's generic diversity Index (H')	4.18* (3.01–3.97)	4.42* (4.00–4.27)	4.30* (4.05–4.12)
Trophic diversity Index (T)	2.63 (2.3–3.1)	3.7 (3.1–4.4)	3.6 (3.0–4.3)
Maturity Index (MI)	2.16 (1.81–2.29)	2.02 (1.64–2.32)	2.23 (2.13–2.57)
Plant Parasite Index (PPI)	2.47 (2.17–2.86)	2.52 (2.44–2.57)	2.24 (2.22–2.26)

* $p < 0.01$ for LA and LC, LA and P, LC and P.

lowest, not on the youngest meadow, but on the many-year-old meadow LC. There was thus no close parallel between the indices H' and MI (Table 6).

The plant parasite index (PPI) was highest on LC, rather lower on LA and decidedly the lowest on P (Table 6).

5. DISCUSSION

During succession ley meadows develop a richer and more complex biocoenotic system (richer vegetation cover, higher plant biomass, more complicated layer structure, increased humus content) (Table 1). The nematode communities of such meadows displayed changes in the abundance of two main taxonomic units (orders): a decrease in the share of Rhabditida and an increase in that of the Tylenchida, albeit with a simultaneous increase in abundance in both groups (Table 2). A change of this kind was noted by Sohlenius and Sandor (1989), in their considerations of the impact of ploughing on grass. However, the increased role of Tylenchida was not of the

order of that noted in this paper many years after ploughing. The Tylenchida include three trophic groups: (so-called "obligate") fungivores – F, facultative plant parasites – FPP (which may be called also facultative fungivores) and obligate plant parasites – OPP. The considerable statistical prevalence of fungivores and facultative fungivores on the many-year-old and permanent meadows, as well as the high abundance of bacterivores there (albeit not differing significantly from those elsewhere) (Table 5) are in accord with the evaluation of Stefaniak et al. (1997), who maintained that the soil of a several-year-old meadow was richest in terms of mi-

croflora. As meadows age, there is a fall in the value of the ratio of bacteria and Actinomycetes to fungi (Stefaniak et al. 1997). The ratios B/F or B/F+FPP used in the present work also declined. Relationships between the two groups attest to the significant predominance of bacterial decomposition on newly-established meadows, and to the significant participation of fungi in the process on many-year-old meadows. The permanent (and even the many-year-old) meadow can thus be compared no-tillage systems whose trophic webs are dominated by fungi (according to Hendrix et al. (1986), although Sohlenius and Sandor (1989) and Wasilewska (1992) were not able to confirm this.

Obligate plant parasites reached significantly higher densities on the many-year-old and permanent meadows than on the newly-established one (Table 5). The differences in the densities of bacterivores were considerably less well-marked, but the ratio of nematodes feeding on bacteria and fungi to obligate plant parasites ($B + F/OPP$) was 2–3 times higher on the youngest meadow. The ratio in question is higher in the first years of formation of meadow biocoenoses and is negatively correlated with meadow age, as has been confirmed in studies of a greater number of meadows in the Suwałki region of Poland (Wasilewska 1994).

The relationship $B + F/OPP$ only provides information on the prevalence of one functional group over the other, but it did prove suitable for an estimation of the degradational changes in dried fen peat soils of alder origin. In these soils there was a huge rise in the abundance of plant parasites in the first 10–20 years after drainage; the ratio attained a value well below 2 (Wasilewska 1991). It may be that the application of this ratio in

other environmental situations may allow for an assessment of limit values with simultaneous reference to the environmental situation.

Trophic structure is a functional classification of a community allowing for an estimate of the pathways along which matter and energy flow (Hendrix et al. 1986). Freckman and Ettema (1993) stressed its weight and suitability, warning at the same time against interpretational errors resulting from a lack of full recognition of the trophic status of many taxa.

The biocoenotic indices used in the analysis of the nematode community (Table 6) indicate meadow age-dependent differentiation. The many-year-old and permanent meadows differ from their newly-established counterpart in having higher Shannon diversity indices (H') and indices of trophic diversity (T). However, there was no positive linear correlation between these variables and age in either this work or a previous one (Wasilewska 1994). The same is also true of the maturity index (MI), which was higher on the permanent meadow than on the newly-established one (albeit with a lower value on the many-year-old meadow than on either of the others). The index in question is used to evaluate different disturbances in terrestrial and aquatic ecosystems (Bongers et al. 1991, Ettema and Bongers 1993, Freckman and Ettema 1993, de Goede and Dekker 1993). It was also seen to be effective in assessing succession, being positively correlated with age, and hence with the stage of succession of meadows (Wasilewska 1994). It is nevertheless necessary to anticipate great variability within it.

The second index of maturity (PPI) was highest on the many-year-old meadow, rather lower on the newly-es-

established meadow and lowest of all on the permanent meadow.

Researched on a greater number of meadow sites, the index in question did not show a clear directly proportional relationship with age (and hence successional stage). It was however highest on 6 to 10 year-old meadows (Wasilewska 1994). Both Bongers (1990) and Freckman and Ettema (1993) showed that PPI rises with the production of roots. In the meadows studied here the net production of roots was lower on older meadows, as was the proportion of live root (while the dead mass of root was

greater) (Szanser 1997). It may be that this can be explained by reference to the reported variation of values of this index on the three studied meadows. It is also worth adding that something quite different is indicated by a number of phytophages on the permanent meadow that was almost 3.5 times greater than on the newly-established meadow and inversely proportional on these meadows to the PPI value. In the view of the author, this index therefore requires further "evaluation", albeit in relation to the excessively limited ranking scale which would seem to limit its sensitivity.

6. CONCLUSIONS

The diversity of the vegetation cover (as a function of meadow age) is reflected in the taxonomic composition, generic and trophic structure, diversity and maturity of nematode communities. Compared to a newly-established meadow, two older meadows had lower relative proportions of representatives of the order Rhabditida and greater relative proportions of those from the Tylenchida (albeit with higher absolute densities of both).

Older meadows also had a lesser degree of taxonomic dominance and higher values for the index of trophic diversity (T) and the Shannon Index of generic diversity (H').

The maturity index (MI) assessed the relationships along the r-K continuum and attested to the greater role of K-

strategists on the permanent meadow, to their lesser role on the newly-established meadow and to their most limited role on the many-year-old meadow. However, in researching a considerably greater number of meadows differing in age, it was possible to document a positive correlation between MI and the age of meadows (Wasilewska 1994).

The plant parasite index (PPI) took on its lowest values on the permanent meadow and higher values on the two younger examples.

The higher densities of fungivores and phytophages on older meadows is evidence of the greater significance of fungus-mediated decomposition and of the rapid form of mineralisation via sucking forms.

7. SUMMARY

The subject of the research was an assessment of taxonomic and trophic structure and the relations between trophic groups of nematodes, as well as a determination of indices of the diversity and maturity of nematode communities.

On the other hand, the aim of the work was to establish the influence of different vegetational environments on the above variables describing these communities.

Studies involved two ley meadows and one

permanent meadow in north-east Poland's Suwałki region. The meadows are of the order Arrhenatheretalia, and they differ in terms of age and vegetational diversity. After ploughing, the 1–3-year-old meadow (LA) had been sown with grass *Dactylis glomerata* L. It was characterised by the smallest number of plant species in the sward, the lowest standing crop and plant biomass and the lowest organic matter content in the soil. The 8–10-year-old meadow (LC) had higher values for these variables (with for example 31 species present in the sward), and the permanent *Anthylli-Trifolietum* meadow (P) had the highest values (Table 1).

Soil samples providing nematodes for study were taken three times (June 1988, August 1989 and June 1990) from meadows LA and LC, and twice (not in 1988) from site P. The extraction, generic and trophic classification of nematodes was done by the methods described in Wasilewska (1971, 1979). The indices determined were a Shannon index of generic diversity (Pielou 1975), MI and PPI indices of community maturity (Bongers 1990) and an index of trophic diversity, T (Heip et al. in Freckman and Ettema 1993).

It was found that the diversity of the vegetation – being a function of meadow age – was reflected in the taxonomic composition, trophic structure, diversity and maturity of nematode communities, since:

1. Older meadows had smaller proportion of nematodes from Rhabditida and greater from Tylenchida (albeit with absolute densities of the representatives of both being higher – Table 2);

2. The greatest number of genera (for the study period as a whole) were noted on the many-year-old meadow, while lower richness

was reported from the newly-established and permanent meadows (Tables 3 and 6), although the mean numbers of genera per sample were greater on older meadows (Table 6);

3. About 60% of the community of nematodes was accounted for by the smallest number of genera on the newly-established meadow and the greatest number on the permanent meadow (Tables 3 and 4);

4. The density of fungivores and facultative plant parasites (also feeding upon fungal hyphae facultatively) was higher on the many-year-old and permanent meadows than on the youngest meadow (Table 5) – attesting to the enhancement of the decomposition of dead organic matter by fungi;

5. The density of obligate plant parasites was several times higher on the older meadows than on the newly-established one (Table 5). In contrast, the ratio of bacterivores and fungivorous nematodes to plant parasites i.e. those gaining nutrition at the expense of live plant tissue is highest on the newly-established meadow (Table 5); attesting to an increase on older meadows of the rapid form of mineralisation of sucking activity;

6. The index of trophic diversity (T) and the Shannon Index of generic diversity (H') are higher on the older meadows than on the youngest. Values of the index of community maturity (MI) were highest on the permanent meadow, albeit lowest on the many-year-old meadow. In contrast, values of the PPI index were lowest on the permanent meadow and higher on the two others (Table 6).

8. POLISH SUMMARY

Przedmiotem badań była ocena struktury taksonomicznej i troficznej, ocena relacji między grupami troficznymi, oraz wyznaczenie wskaźników różnorodności i dojrzałości zespołów nicieni. Celem badań natomiast było ustalenie wpływu zróżnicowanego środowiska roślinnego na wspomniane parametry opisujące te zespoły.

Badania przeprowadzono na dwóch przemiennych łąkach i jednej trwałej, usytuowanych w płu-wsch Polsce na terenie Suwalszczyzny w okolicy wsi Malesowizna. Łąki te, należące do rzędu Arrhenatheretalia zróżnicowane były pod względem wieku i szaty roślin-

nej. Łąka 1–3 letnia (LA) obsiana po zaoraniu trawą kupkówką *Dactylis glomerata* L. charakteryzowała się najniższą liczbą gatunków roślin w runi, najniższą biomasą roślin, najniższą zawartością materii organicznej w glebie; na łące 8–10 letniej (LC) parametry te były wyższe (np. w runi występowało już 31 gatunków), a na łące trwałej (P) z zespołem *Anthylli-Trifolietum* – najwyższe (tab. 1).

Próby glebowe dla pozyskania nicieni pobrano trzykrotnie (w czerwcu 1988, sierpniu 1989 i czerwcu 1990) na stanowiskach LA i LC oraz dwukrotnie (wykluczając rok 1988) na stanowisku P. Ekstrakcję nicieni i klasyfikację

do rodzajów i grup troficznych przeprowadzono wg wcześniej opisanych metod (Wasilewska 1971, 1979). Wyznaczono następujące wskaźniki: wskaźnik różnorodności rodzajowej Shannon'a (Pielou 1975), wskaźnik dojrzałości zespołu MI i PPI (Bongers 1990) oraz wskaźnik zróżnicowania troficznego T (Heip et al. w: Freckman i Ettema 1993).

Stwierdzono, iż różnorodność szaty roślinnej, będąca funkcją wieku łąki, znajduje odbicie w składzie taksonomicznym, strukturze troficznej, różnorodności i dojrzałości zespołów nicieni gdyż:

1. Na łąkach starszych nastąpił spadek udziału nicieni z rzędu Rhabditida i wzrost udziału rzędu Tylenchida, chociaż bezwzględne zagęszczenie przedstawicieli obu rzędów wzrosło (tab. 2).

2. Najwyższą, sumaryczną dla okresu badawczego, liczbę rodzajów stwierdzono na łące wieloletniej, a na łące nowo założonej i trwałej, mniejszą (tab. 3 i 6). Średnia w próbie liczba rodzajów wzrastała z wiekiem łąk (tab. 6).

3. Najmniej rodzajów tworzyło około 60% zgrupowania na łące nowo założonej, a najwięcej – na łące trwałej (tab. 3 i 4).

4. Na łące wieloletniej i trwałej zagęszczenie grzybożerców oraz fakultatywnych pasożytów roślin (fakultatywnie odżywiają się też strzępkami grzybów) było wyższe niż na łące najmłodszej (tab. 5) wskazując na nasilenie rozkładu martwej materii organicznej przy udziale grzybów.

5. Obligatoryczne pasożyty roślin wykazały kilkakrotnie wyższe zagęszczenie na łąkach starszych niż na łące nowo założonej (tab. 5). Natomiast stosunek liczebności nicieni spasających bakterie i grzyby do nicieni odżywiających się kosztem żywej tkanki roślinnej jest najwyższy na łące nowo założonej (tab. 5). Wskazuje to na wzrost nasilenia szybkich form mineralizacji przy udziale form ssących na łąkach starszych.

6. Wskaźnik różnorodności troficznej (T) i wskaźnik różnorodności rodzajowej Shannon'a (H') są wyższe na łąkach starszych niż na łące najmłodszej. Wskaźnik dojrzałości zespołu (MI) był najwyższy na łące trwałej, jednak najniższy na łące wieloletniej. Wskaźnik PPI natomiast był najniższy na łące trwałej i wyższy na dwóch pozostałych łąkach (tab. 6).

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