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Nematode communities of river banks and adjacent meadows in the Slovak Republic

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Summary

An investigation of the nematode communities of river banks and adjacent meadows of five localities in the Slovak Republic was conducted. The specific structure included 111 species from 67 genera in river banks and 66 species from 49 genera in meadows. The species *Paramphidelus uniformis, Mononchus aquaticus, Ogma danubiale, Sphaeronema* sp. and *Tylolaimophorus* sp. from river banks vegetation and *Campydora demonstrans* from meadows are new for the fauna of the Slovak Republic. In river banks and adjacent neighbouring meadows a high variability in taxa diversity between both ecosystems was recorded with higher taxa diversity in soil of river banks. This was associated with the occurrence of taxa preferring wet soil conditions with river bank vegetation. Such were *Achromadora terricola, Paratrophurus bursifer, Hemicycliophora* spp., *Longidorus poessneckensis, Xiphinema diversicaudatum, Trichodorus variopapillatus*, and many others. Specific and genera diversity did not correlate with the abundance of nematodes. In both types of ecosystems plant parasitic nematodes dominated (more than 50 % of total abundance), mainly with preponderance of *Helicotylenchus* spp., in some localities of river banks with preponderance of genera *Tylenchorhynchus, Longidorus*, and *Trichodorus*. The plant feeders were followed in domination by bacterial feeders in both ecosystems. Higher proportion of omnivores was observed in meadows, joined with preponderance of dorylaimid nematodes. Higher proportion of predators in river banks was associated with preponderance of mononchid nematodes. Indices of species and genera diversity (H´spp and H´gen) reflected variations in nematode diversity in both types of ecosystems. Although the average indices MI, PPI and ratio MI/PP indicate maturity and stability of natural ecosystems studied, the diversity of ecological indices within individual localities presents heterogenity of nematode communities, which can be in each particular locality influenced in different ways, mostly by fluctuation of water level in soil caused by unstable water level of rivers and by inundations.

Key words: nematode communities; river banks; meadows; Slovak Republic

Introduction

The structure of free living soil and plant parasitic nematode communities is a reflection of different biotic and abiotic conditions in which nematodes are living, first of all soil and climatic conditions joined with specific plant cover. Nematodes form a taxonomically and environmentally important component of biocenosis in an ecosystem, and many species or taxa of higher position, or nematode trophic groups are symptomatic of specific ecosystems and are characterized by different sensibility to environmental changes. This feature of nematodes makes them effective ecological bioindicators of soil stability and environment (Bongers, 1990; De Goede, 1993; Wasilewska, 1997; Bongers & Ferris, 1999; etc.).

The information on nematode communities of natural ecosystems from Slovakia is currently insufficient, since the investigation was previously more concentrated on different cultivated agroecosystems or on geographical distribution of particular phytopathological and economical taxa in some specific ecosystems. Within the last years there were e.g. investigations of Longidoridae in various ecosystems (Lišková & Brown, 2003), of Criconematidae (Lišková *et al.*, 2004), and of *Heterodera*, *Globodera* and *Punctodera* in various natural and cultivated ecosystems (Sturhan & Lišková, 2004a). Some information on nematode communities of natural ecosystems in Slovakia, including grasslands and pasturelands, comes from research by Šály (1983), Valocká and Sabová (1997) and Valocká *et al.*, (2001).

The purpose of this study was to know and to compare the structure of nematode communities of natural river banks and adjacent grasslands with meadows of fluvial plains in some localities of Slovakia.

Material and Methods

Communities of nematodes were investigated in five localities in the middle and east Slovakia.

Characteristic of localities

Detva, orographic unit Zvolenská kotlina, valley, at altitude 410 m, 48°34´N, 19°25´E, sampling sites along small river Slatina, river bank with sandy, gravelled soil with pH 3.6, meadow with loamy-sandy gravelled soil with pH 4.7.

Krásnohorská Dlhá Lúka (*K. D. Lúka*), orographic unit Slovenský kras, karst, at altitude 300 m, 48°43´N, 20° 43´E, sampling sites along small river Čremošná, river bank sandy soil with pH 5.8, meadow with loamy-sandy soil with pH 6.0.

Lipovník, orographic unit Rožňavská kotlina, valley, at altitude about 340 m, 48°42´N, 20°32´E, sampling sites along small river Čremošná, river bank with sandy, loamy-sandy wet soil, meadow with sandy-loamy and moist soil, soil from both places with pH 6.0.

Svätá Mária (*S. Mária*)., orographic unit Východoslovenská rovina, plane, at altitude 110 m, 48°29´N, 21°52´E, sampling sites along river Latorica with loamy, at river bank very wet soil.

Veľké Raškovce (*V. Raškovce*), orographic unit Východoslovenská rovina, plane, at altitude about 110 m, 48°34´N, 21°25´E, sampling sites along river Laborec, loamy soil. Soil from locality Svätá Mária and Veľké Raškovce both of pH 4.8.

The river banks of investigated localities are characterized by specific type of vegetation, with the most common types being *Alnus glutinosa*, *Salix* spp. and *Populus* spp. with the undergrowth of *Urtica dioica*, *Rubus caesius* and *Deschampsia caespitosa*. Distinctive for the river banks is their varied, frequently changing configuration, sometimes flat, in other cases one or more meters high and very abrupt. The adjacent riverine, or fluvial plains along the rivers or smaller streams are larger or very narrow, sometimes of the width of 2 – 5 meters, generally flat plane with grassland, and commonly utilized meadows for hay-making. Their flora is comprising of mostly *Festuca pratensis*, *F. arundinacea*, *Salvia pratensis*, *Ranunculus polyanthemos* and *Cirsium canum*. Both ecosystems are defined by fluvisol soil type - gravelled, stony, sandy, loamy or clay soils, with variability in pH 3.6 – 6.0, derived from alluvial sediments of different origin. They can be inundated, regularly in spring or during storms.

Soil samples were collected from the rhizosphere of river banks vegetation and adjacent neighbouring meadows in May and June of the 2000. Nematodes were isolated from 500 g of mixed soil by using Cobb flotation-sieving method in addition to final extraction using Baermann funnel. Isolated nematodes were fixed in FAA and determined in permanent glycerine slides.

For nematode diversity of both ecosystems and for ecological evaluation of nematode communities, following indices were used:

- Number of nematode species.
- Number of nematode genera - determined genera were allocated into five trophic groups according to classification system of Yeates *et al.* (1993). These trophic groups are following: bacterial feeders, fungal feeders, plant feeders, omnivores, and predators. Plant feeders were distinguished in plant parasite - obligate parasites and other - root-fungal feeders (facultative plant feeders) which include *Tylenchus* spp. and related species.
- Abundance of nematodes in 500 g of soil.
- Shannon index of diversity for species (H´spp) and for genera (H´gen), proposed by Shannon and Weaver (1949).
- Maturity Index (MI) for nonparasitic nematodes. MI ratio is based on separation of nematode taxa into c-p scale 1-5, based on life strategy from colonisers to persisters (Bongers (1990)). Lower value indicates an earlier stage of succession or disturbance of environment, and higher value indicates less disturbed conditions (Wasilewska, 1997).
- Plant Parasitic Index (PPI) for plant parasitic nematodes, proposed by Bongers, (1990).
- PPI/MI ratio: Proportion of Plant Parasitic Index to Maturity Index, ratio introduced by Bongers and Korthals (1995).
- B/F ratio: Proportion of Bacterial Feeders to Fungal Feeders, ratio proposed by Wasilewska (1997).

Results

Taxonomical evaluation

A total of 111 nematode species including unidentified species marked as nematode sp. from 67 genera was found in river banks, and 66 species from 49 genera in adjacent meadows and 39 species were common in both types of ecosystems (Table 1 and 2). The number of nematode species in individual types of ecosystems varied from 18 (meadow, V. Raškovce) to 54 (river bank, Detva). River banks had greater species richness of nematodes than adjacent meadows, except for locality K. D. Lúka. The total abundance of nematodes in river banks was 180 – 1241 and in meadows 219 – 1208 individuals in 500 g of soil (Table 3).

A large taxonomic variability of nematode species and genera in geographically neighbouring investigated ecosystems has been observed. A higher variability in structure of all nematode taxa has been observed in river banks, where some species, or higher taxa as well, can be considered as nematode species preferring humid soils, e.g. *Theristus agilis*, *Achromadora terricola*, *Meloidogyne ardenensis*, *Paratrophurus bursifer*, *Hemicycliophora* spp., *Ogma danubiale*, *Sphaeronema* spp., some *Paratylenchus* spp., *Mononchus aquaticus*, *Longidorus poessneckensis*, *Xiphinema diversicaudatum*, and *Trichodorus variopapillatus*. Most nematode individuals found in river banks belonged to dominant genera (proportion $\geq$ 5 %) have been *Tylenchorhynchus* (23.0 %), *Helicotylenchus* (8.1 %), *Trichodorus* (6.2 %) and *Hemicycliophora* (5.7 %), subdominant genera (< 5 %) have been e.g. *Rhabditis* (4.7 %), *Paratrichodorus*

Table 1. Specific structure of nematode communities at five localities of natural river banks in the Slovak Republic and abundance of taxa in 500 g of soil

Nematode species	Locality				
	Detva	K. D. Lúka	Lipovník	S. Mária	V. Raškovce
Order: MONHYSTERIDA					
1. *Theristus agilis* (de Man, 1880)				2	
Order: CHROMADORIDA					
2. *Achromadora terricola* (de Man, 1880)	2				
Order: ARAEOLAIMIDA					
3. *Anaplectus granulosus* (Bastian, 1865)	1				
4. *Plectus communis* Bütschli, 1873	21	9	2	8	2
5. *Plectus opisthocirculus* Andrássy, 1958					1
6. *Plectus parvus* Bastian, 1865	8				
Order: RHABDITIDA					
7. *Cephalobus persegnis* Bastian, 1865	12	3	17	3	2
8. *Eucephalobus mucronatus* (Kozlowska & Roguska-Wasilewska, 1963)	1	5	5	1	
9. *Eucephalobus striatus* (Bastian, 1865)	15	2		2	
10. *Acrobeles ciliatus* Linstow, 1877	4				
11. *Chiloplacus symmetricus* (Thorne, 1925)					7
12. *Panagrolaimus rigidus* (Schneider, 1866)				1	
13. *Rhabditis* sp.	17	85	15	9	3
14. *Steinernema* sp.	24	15		6	12
Order: DIPLOGASTERIDA					
15. *Diplogaster* sp.	2				5
16. *Pristionchus lheritieri* (Maupas, 1919)	1				
Order: APHELENCHIDA					
17. *Aphelenchus avenae* Bastian, 1865	4	2		1	2
18. *Aphelenchoides blastophthorus* Franklin, 1952				6	
19. *Aphelenchoides composticola* Franklin, 1957					4
20. *Aphelenchoides parietinus* (Bastian, 1865)				1	
Order: TYLENCHIDA					
21. *Tylenchus davainei* Bastian, 1865	2			10	
22. *Tylenchus* sp.			4		1
23. *Aglenchus agricola* (de Man, 1884)	13				1
24. *Coslenchus costatus* (de Man, 1921)	5				8
25. *Filenchus polyhypnus* (Steiner & Albin, 1946)					6
26. *Filenchus thornei* (Andrássy, 1954)	10	7	26	3	
27. *Boleodorus acutus* Thorne, 1941				1	
28. *Basiria gracilis* (Thorne, 1949)				8	
29. *Malenchus exiguus* (Massey, 1969)				8	
30. *Ditylenchus intermedius* (de Man, 1880)	2				7
31. *Nothotylenchus* sp.	3	2		3	1
32. *Helicotylenchus digonicus* Perry in Perry, Darling & Thorne, 1959	5				
33. *Helicotylenchus pseudodigonicus* Szczygiel, 1970				5	
34. *Helicotylenchus pseudorobustus* (Steiner, 1914)	11	80	77	13	
35. *Helicotylenchus* sp.	4	25			
36. *Rotylenchus robustus* (de Man, 1876)	4	22			1
37. *Rotylenchus pumilus* (Perry in Perry, Darling & Thorne, 1959)		22	2		
38. *Rotylenchus* sp.				2	
39. *Pratylenchus crenatus* Loof, 1960	21				
40. *Pratylenchus pratensis* (de Man, 1880)	18			3	12
41. *Pratylenchus* sp.			3		

42. *Pratylenchoides crenicauda* Winslow, 1958				3	
43. *Meloidogyne ardenensis* Santos, 1968			5		
44. *Heterodera* sp.		1			
45. *Tylenchorhynchus* sp.	597	18		1	2
46. *Bitylenchus dubius* (Bütschli, 1873)				3	5
47. *Paratrophurus bursifer* (Loof, 1960)		17	98		
48. *Merlinius brevidens* Siddiqi, 1970					5
49. *Merlinius nanus* (Allen, 1955)	6				
50. *Psilenchus hilarulus* de Man, 1921				2	
51. *Hemicycliophora thienemanni* (Schneider, 1925)	53		85		
52. *Hemicycliophora typica* de Man, 1921		16			
53. *Criconema (C.) annuliferum* (de Man, 1921)				1	
54. *Criconema (N.) mutabile* (Taylor, 1936)	2				
55. *Ogma danubiale* Andrássy, 1985		1			
56. *Macroposthonia curvata* (Raski, 1952)				9	
57. *Macroposthonia dherdei* de Grisse, 1967				2	
58. *Macroposthonia rustica* (Micoletzky, 1915)	4				
59. *Macroposthonia xenoplax* (Raski, 1952)				20	
60. *Sphaeronema* sp.			4		
61. *Paratylenchus bukowinensis* Micoletzky, 1922	4		3	1	
62. *Paratylenchus microdorus* Andrássy, 1959			2		9
63. *Paratylenchus* sp.	3				
64. *Paratylenchus projectus* Jenkins, 1956				3	
65. *Paratylenchus straeleni* (de Coninck, 1931)				4	4
Order: ENOPLIDA					
66. *Alaimus primitivus* de Man, 1880	27		1	36	8
67. *Alaimus* sp.		4			
68. *Paramphidelus dolichurus* (de Man, 1876)			1		3
69. *Paramphidelus uniformis* (Thorne, 1939)	7				
70. *Paramphidelus* sp.			3	6	
71. *Tripyla affinis* de Man, 1880				2	
72. *Tripyla filicaudata* de Man, 1880	6			12	
73. *Tripyla glomerans* Bastian, 1865	7				
74. *Tripyla setifera* Bütschli, 1873	3				
75. *Tripyla* sp.	3	2			
76. *Tobrilus* sp.				1	
77. *Prismatolaimus intermedius* (Bütschli, 1873)	8			10	
78. *Aulolaimus* sp.				5	
Order: MONONCHIDA					
79. *Mononchus aquaticus* Coetzee, 1968			3		
80. *Clarkus parvus* (de Man, 1880)	3			2	
81. *Mylonchulus brachyuris* (Bütschli, 1873)		6			2
82. *Mylonchulus sigmaturus* (Cobb, 1917)			7		
83. *Mylonchulus subtenuis* (Cobb, 1917)				29	
84. *Miconchus* sp.	1				
85. *Anatonchus tridentatus* (de Man, 1876)				6	
Order: DORYLAIMIDA					
86. *Nygolaimus bisexualis* Thorne, 1930				4	
87. *Nygolaimus clavicaudatus* Altherr, 1953		3	2		
88. *Nygolaimus hartingii* (de Man, 1880)	2				1
89. *Mesodorylaimus tenuicaudatus* (Bastian, 1865)	1		3		
90. *Mesodorylaimus bastiani* (Bütschli, 1873)			2		
91. *Mesodorylaimus bastianoides* (Daday, 1894)	3				
92. *Eudorylaimus carteri* (Bastian, 1865)			3		
93. *Eudorylaimus muscorum* (Skwarra, 1921)		2			
94. *Eudorylaimus* sp.	35	6		37	9
95. *Aporcelaimellus obtusicaudatus* (Bastian, 1865)	4		11	16	10

96. *Thornia propinqua* (Paesler, 1941)			4		
97. *Enchodelus macrodorus* (de Man, 1880)	8	3			
98. *Pungentus engadiensis* (Altherr, 1950)	2		4		
99. *Longidorus elongatus* (de Man, 1876)	25				
100. *Longidorus leptocephalus* Hooper, 1961	34	3	1		8
101. *Longidorus poessneckensis* Altherr, 1974				1	
102. *Xiphinema diversicaudatum* (Micoletzky, 1927)				21	
103. *Oxydirus oxycephalus* (de Man, 1885)			1	2	
104. *Dorylaimellus mirabilis* (de Man, 1876)				6	10
105. *Tylencholaimus minimus* de Man, 1876			56		
106. *Tylencholaimus stecki Steiner, 1914*	13	9		4	25
107. *Tylolaimophorus* sp.					1
108. *Trichodorus primitivus* (de Man, 1880)	42				
109. *Trichodorus sparsus* Szczygiel, 1968	2				
110. *Trichodorus variopapillatus* Hooper, 1972			11	110	3
111. *Paratrichodorus pachydermus* (Seinhorst, 1954)	126				
Total abundance	1241	370	461	455	180

(4.6 %), *Paratrophurus* (4.2 %) and *Aporcelaimellus* (3.2 %). In meadows the dominant genera have been *Helicotylenchus* (39.3 %), *Rotylenchus* (9.0 %), and *Aporcelaimellus* (14.9 %), subdominant genera *Longidorus* (4 %) and *Rhabditis* (3 %).

The species *Paramhidelus uniformis, Mononchus aquaticcus, Ogma danubiale, Sphaeronema* sp., and *Tylolaimophorus* sp. from river banks and *Campydora demonstrans* from meadows, are new for the fauna of the Slovak Republic.

Ecological evaluation of nematode communities based on trophic groups and ecological indices

Plant parasitic nematodes were dominant in both investigated ecosystems, in meadows with an average proportion of total nematodes 55.4 % and with 53.5 % in river banks (Table 3). A very high proportion of *Helicotylenchus* spp. from all plant feeders in meadows was observed in Detva (96 %), in the other localities it varied (16 – 66 %). In Lipovník a high (27 %) proportion of *Rotylenchus* spp. was observed. In comparison with river banks vegetation, *Helicotylenchus* spp. occurred at all localities, but with lower proportion of total nematode abundance of plant feeders - with maximum of 51 % at locality K. D. Lúka. In Detva a high proportion of *Tylenchorhynchus* sp. was observed in the soil of river bank (63 %), relatively high proportion of trichodorid nematodes (17 %), *Hemicycliophora* and *Longidorus* (5.5 %, resp. 6.1 %) from plant feeders. In Lipovník genus *Paratrophurus* was found with one species *P. bursifer* only, with proportion of 34 %, *Hemicycliophora* with 29 %, and in S. Mária *Trichodorus* reached 54 % from all plant feeders. Genera *Hemicycliophora*, *Paratrophurus*, *Longidorus*, and *Paratrichodorus* occurred mostly in light sandy soils. Moreover, *Paratrophurus* was identified in two geographically close localities, Lipovník and K. D. Lúka only. The proportion of root-fungal feeders was of 6.2 % in river banks and 4.8 % in meadows.

The subdominant trophic group of both types of ecosystems were the group of bacterial feeders with the proportion of 17.2 %, with the most abundant genera *Rhabditis, Plectus, Eucephalobus,* and *Alaimus* in river banks. In meadows the bacterial feeders occurred with 14.3 %, and the most abundant genera were *Rhabditis*, *Cephalobus,* and *Eucephalobus*. The following trophic group was the group of omnivores, with fluctuating proportion within individual localities and in both ecosystems (8.6 % in river banks and remarkably higher 17.0 % in meadows) with preponderance of genus *Eudorylaimus*, which in meadow at locality Detva reached 40 % of total nematode abundance. The fungal feeders occurred with the proportion of 7.2 % in river banks and with 5.6 % in grasslands, with expressive fluctuation within individual localities. The trophic group of predators was the least abundant group in nematode communities of both ecosystems. In river banks their proportion was 4.4 % and in meadows 2.4 %, with a fluctuation within individual localities.

The H´spp values in river banks were 2.38 – 3.13, H´gen 2.25 – 2.99, in meadows H´spp were 1.39 – 3.06, H´gen 1.29 – 3.21.

The Maturity index (MI) was somewhat lower in river banks (2.7) than in meadows (2.9), which was not a dramatic difference. A higher value of MI in meadows influenced omnivores (17 % from the total abundance) and mainly nematodes of the genus *Aporcelaimellus*; in river banks omnivores (8.6 %) with dominance of *Eudorylaimus* and *Aporcelaimellus* were also present in combination with predators (4.4 %) with dominance of *Mylonchulus, Theristus* and *Pungentus* spp..

The plant parasitic index (PPI), which is calculated similarly to MI but from plant parasites only, was in all localities and ecosystems relatively equal and ranged 3.00 – 3.95. The highest PPI = 3.72 in the river bank of S. Mária was linked with high population density of *Trichodorus variopapillatus,* and PPI = 3.95 in grassland at locality V. Raškovce was linked with a high population of *Longidorus leptocephalus*. The ratio PPI/MI was relatively equal in both ecosystems (average value of 1.22 in river banks and of 1.17 in meadows). This ratio indicated compounded

Table 2. Specific structure of nematode communities at five localities of meadows in the Slovak Republic and abundance of taxa in 500 g of soil

Nematode species	Locality				
	Detva	K. D. Lúka	Lipovník	S. Mária	V. Raškovce
Order : ARAEOLAIMIDA					
1. *Anaplectus granulosus* (Bastian, 1865)		15	9		
2. *Plectus assimilis* Bütschli, 1873		5			
3. *Plectus longicaudatus* Bütschli, 1873		4			
4. *Plectus parvus* Bastian, 1865		2			
Order: RHABDITIDA					
5. *Cephalobus nanus* de Man, 1880		2	7	2	
6. *Cephalobus persegnis* Bastian, 1865	11	24	14	7	21
7. *Eucephalobus mucronatus* (Kozlowska & Roguska – Wasilewska, 1963)	9			3	7
8. *Heterocephalobus elongatus* (de Man, 1880)		8			
9. *Chiloplacus propinguus* (de Man, 1921)		5			
10. *Panagrolaimus rigidus* (Schneider, 1866)	2				21
11. *Rhabditis* sp.	23	43	4	10	20
12. *Bunonema reticulatum* Richters, 1905		4			
13. *Steinernema* sp.	11	7			
Order: APHELENCHIDA					
14. *Aphelenchus avenae* Bastian, 1865		5	5	3	39
15. *Seinura* sp.		1			
Order: TYLENCHIDA					
16. *Aglenchus agricola* (de Man, 1884)			4		
17. *Filenchus filiformis* (Bastian, 1865)	2				
18. *Filenchus polyhypnus* (Steiner & Albin, 1946)			7		
19. *Filenchus thornei* (Andrássy, 1954)			2	1	
20. *Boleodorus thylactus* Thorne, 1941	1	17	13	1	
21. *Basiria affinis* Thorne & Malek, 1968				2	
22. *Neopsilenchus magnidens* (Thorne, 1949)					12
23. *Malenchus bryophilus* (Steiner, 1914)			2	3	
24. *Malenchus exiquus* (Massey, 1969)	4	12			
25. *Malenchus platycephalus* (Thorne & Malek, 1968)		1			
26. *Helicotylenchus canadiensis* Waseem, 1961	4	2	85		25
27. *Helicotylenchus digonicus* Perry in Perry, Darling & Thorne, 1959	523	33	487	51	44
28. *Helicotylenchus pseudorobustus* (Steiner, 1914)			56		
29. *Rotylenchus goodeyi* Loof & Oostenbrink, 1958		9	260		8
30. *Rotylenchus pumilus* (Perry in Perry, Darling & Thorne, 1959)		17			
31. *Pratylenchus crenatus* Loof, 1960	3	3		3	
32. *Pratylenchus pratensis* (de Man, 1880)			1		
33. *Pratylenchus thornei* Sher & Allen, 1953	15				6
34. *Meloidogyne hapla* Chitwood, 1949		15			
35. *Heterodera* sp.		29			
36. *Tylenchorhynchus* sp.		51	1	35	
37. *Bitylenchus dubius* (Bütschli, 1873)	3	2			14
38. *Merlinius brevidens* (Allen, 1955)		33			4
39. *Psilenchus hilarulus* de Man, 1921	17	15	2	8	1
40. *Hemicycliophora* sp.		4			
41. *Criconema* (C.) *annuliferum* (de Man, 1921			6		
42. *Macroposthonia antipolitana* (de Guiran, 1963)				2	
43. *Macroposthonia curvata* (Raski, 1952)			8		

44.	*Macroposthonia xenoplax* (Raski, 1952)		5			
45.	*Paratylenchus microdorus* Andrássy, 1959			2		
46.	*Paratylenchus* sp.			4		
Order: ENOPLIDA						
47.	*Alaimus primitivus* de Man, 1880	6	10	24	5	
Order: MONONCHIDA						
48.	*Clarkus parvus* (de Man, 1880)	3		4	4	
49.	*Mylonchulus* sp.					26
50.	*Anatonchus tridentatus* (de Man, 1876)	3			3	
Order: DORYLAIMIDA						
51.	*Nygolaimus* sp.				1	
52.	*Prodorylaimus brigdammensis* de Man, 1876)		3	2	3	
53.	*Mesodorylaimus bastiani* (Bütschli, 1873)		7		12	5
54.	*Mesodorylaimus centrocercus* (de Man, 1880)				5	
55.	*Eudorylaimus* sp.	46				
56.	*Aporcelaimellus obtusicaudatus* (Bastian, 1865)	443	7	7	31	19
57.	*Enchodelus macrodorus* (de Man, 1880)		3	1	3	
58.	*Longidorella parva* Thorne, 1939				3	
59.	*Longidorus leptocephalus* Hooper, 1961		6	19		91
60.	*Longidorus juglandicola* Lišková, Robbins & Brown, 1997			22		
61.	*Dorylaimoides micoletzkyi* (de Man, 1921)		4			
62.	*Oxydirus oxycephalus* (de Man, 1885)			32		
63.	*Dorylaimellus mirabilis* (de Man, 1876)					5
64.	*Tylencholaimus zeelandicus* de Man, 1876	79	5	2	9	
65.	*Campydora demonstrans* Cobb, 1920		1			
66.	*Diphtherophora communis* de Man, 1880,			4		
Total abundance		1208	450	1106	219	347

trophic resources for nematodes.

In both investigated types of ecosystems the average value of ratio B/F was very high, in river banks 5.26, in grasslands 4.88, but with a substantial fluctuation in individual localities within both ecosystems investigated.

Discussion

A large taxonomical variability in ecosystems studied was observed. The diversity of nematodes namely from river banks was characterised by occurrence of taxons characteristic for this type of ecosystem. Many authors from abroad consider numerous nematode taxa to be symptommatic of humid ecosystems, as do we based on our own results; *Theristus agilis* and *Achromadora terricola* has been studied by Meyl (1960), *Meloidogyne ardenensis* has been observed in numerous localities with humid soils in Slovakia by Lišková and Sturhan (1998), similarly *Paratrophurus bursifer* (Sturhan and Lišková, 2004b), *Longidorus poessneckensis*, *Xiphinema diversicaudatum* (Lišková, 2001), and *Trichodorus variopapillatus* (Lišková and Sturhan, 1999). Many *Hemicycliophora* species occur in moist soil conditions throughout the world (Brzeski, 1974); *Ogma danubiale* is known from dune sand along the river Danube in Hungary (Andrássy, 1985a) and from similar habitat in Romania (Popovici & Ciobanu, 2000a); *Mononchus aquaticus* is in Europa known from Hungary, Great Britain, Italy, Russia (Andrássy, 1985b) and from river banks and other wet soils in former Yugoslavia (Barsi, 1989); and *Paratylenchus straeleni* is known from wet soil in Poland (Brzeski, 1995). In our study, numerous nematode species of genera *Aphelenchoides*, *Paramphidelus*, *Tripyla*, *Trichodorus,* and *Paratrichodorus* have been very frequently observed at some localities of river banks, but these nematodes have not occurred in meadows. Highly peculiar is the absence of *Trichodorus* spp., as well as the absence of species such as *Xiphinema diversicaudatum* and *Longidorus elongatus* in alluvial meadows, since these nematodes were repeatedly observed in this type of vegetation during our previous study (Lišková & Sturhan, 1999; resp. Lišková & Brown, 2003). On the contrary, some species have been observed exclusively in meadows, e.g. *Bunonema reticulatum*, *Seinura* sp., *Basiria affinis*, *Neopsilenchus magnidens*, *Pratylenchus thornei*, and *Diptherophora communis*. In addition, the comparison of both investigated ecosystems disclosed a higher specific richness of identified individual species of some genera in river banks, e.g. *Helicotylenchus, Hemicycliophora, Macroposthonia, Criconema, Paratylenchus, Mylonchulus,* and *Mesodorylaimus*.

The abundance of nematodes was characteristic by large variability. In contrary to the results of Háněl (1995) and of

Table 3. Nematode community structure of natural river banks and adjacent meadows at five localities in the Slovak Republic

Nematodes	Locality: Detva		K.D.Lúka		Lipovník		Svätá Mária		V. Raškovce		Mean value	
	River bank	Meadow	River bank	Meadow	River bank	Meadow	River bank	Meadow	River bank	Meadow	River banks x ± S.D.	Meadows x ± S.D.
Number of species	54	20	27	38	31	31	51	25	33	18	39.2 ± 12.4	26.4 ± 8.2
Number of genera	41	18	23	34	28	27	43	25	31	17	33.2 ± 8.6	24.2 ± 7.0
Total abundance	1241	1208	370	450	461	1106	455	219	180	347	541.4 ± 407.2	666.0 ± 457.1
Bacterial feeders %	10.0	4.2	29.2	34.0	9.5	6.1	20.0	13.2	17.2	13.8	17.2 ± 8.1	14.3 ± 11.8
Fungal feeders %	1.4	6.5	3.0	2.4	12.1	1.0	2.6	5.5	17.8	12.7	7.4 ± 7.2	5.6 ± 4.5
Root-fungal feeders %	2.8	2.0	2.4	10.0	6.5	2.7	5.9	5.5	13.3	3.8	6.2 ± 4.4	4.8 ± 3.2
Plant parasites %	77.4	45.4	55.4	46.4	63.1	86.0	44.4	43.8	27.2	55.3	53.5 ± 19.0	55.4 ± 17.7
Omnivores %	4.3	40.5	3.0	5.3	6.1	3.8	13.4	28.3	16.1	6.9	8.6 ± 5.8	17.0 ± 16.5
Predators %	2.2	0.5	3.0	0.2	2.6	0.4	12.3	3.7	1.7	7.4	4.4 ± 4.5	2.4 ± 3.1
Insect parasites %	1.9	0.9	4.0	1.6	-	-	1.3	-	6.7	-	3.5 ± 2.4	1.3 ± 0.5
H´spp	2.38	1.39	2.57	3.06	2.46	1.91	3.13	2.69	3.03	2.41	2.71 ± 0.34	2.29 ± 0.66
H´gen	2.25	1.29	2.31	3.21	2.43	1.51	2.97	2.49	2.99	2.28	2.59 ± 0.36	2.16 ± 0.77
MI	2.67	3.70	1.8	2.10	3.11	2.93	3.21	3.29	2.89	2.58	2.74 ± 0.56	2.92 ± 0.62
PPI	3.29	3.00	3.03	3.06	3.03	3.31	3.72	3.00	3.12	3.95	3.24 ± 0.29	3.26 ± 0.40
PPI/MI ratio	1.23	0.81	1.67	1.46	0.97	1.13	1.16	0.91	1.08	1.53	1.22 ± 0.27	1.17 ± 0.32
B/F ratio	7.14	0.64	9.73	14.16	0.78	6.10	7.69	2.40	0.97	1.09	5.26 ± 4.11	4.88 ± 5.6

Popovici and Ciobanu (2000b), in our investigation a higher number of observed nematode species was not positively correlated with a higher abundance of nematodes, the only exception being at locality Detva.

From trophic groups, plant parasitic nematodes were dominant in both investigated ecosystems. Similar domination of plant feeders in grasslands was recorded in Slovakia by Valocká *et al.* (2001) and in Romania by Popovici and Ciobanu (1996). Domination of plant feeders in ecosystems, or increase of these nematodes, and especially strong dominance of some particular species indicates "long term" type of vegetation (Karg *et al.*, 1990, Wasilewska, 1994). This principle of domination is applicable to numerous longidorid species from Slovakia, associated exclusively with natural forest ecosystems, fruit trees, or grapevine (Lišková & Brown, 2003).

The second most abundant trophic group of bacterial feeders was recorded. According to Freckman and Ettema (1993) and Wasilewska (1997), higher proportion of bacterial feeders is a reflection of rich decomposition of organic matter. In soil of the two types of ecosystems studied, higher proportion of bacterial feeders in river banks can therefore be possibly explained by richer root system of perennial trees and shrubs in combination with different herbaceous plants, in addition to the annual amount of leaves from the trees in the autumn, a potential source of higher amount of organic matter. The group of bacterial feeders were followed by omnivores and fungal feeders. According to Háněl (1996), omnivores can be abundant in soils with grassland, because omnivores, besides bacterial feeders, were the most abundant trophic group in south Bohemian meadow. Increasing value of fungal feeders is associated with increased soil acidity caused by different factors, e.g. by mineral fertilization of soil (Sohlenius & Wasilewska, 1984) and by acid rains (Wasilewska, 1996). In river banks and meadows at locality V. Raškovce, our results agree with the results of these authors (acid soils were accompanied with very high proportion of fungal feeders), but in the other localities the proportion of fungal feeders fluctuated and did not correlate with soil pH.

The least abundant trophic group with high fluctuation within localities in both ecosystems was the group of predators. The increased abundance of predators in nematode communities is an indicator of stability and naturalness of ecosystems (Wasilewska, 1975, 1997). According to these results, river banks can be considered being a more stable ecosystem, but in comparison with omnivores - group similarly considered as factor of stability, meadows form the more stable ecosystem. Our perception is that both these ecosystems represent heterogenous ecosystems influenced by numerous factors, most importantly by the behaviour of rivers, inundations, height of water level of rivers affecting the water level in soils of both ecosystems, occasional removal of soil by rivers or alluviation, etc.. More humid conditions of river banks are responsible for species diversity in this ecosystem, first of all for occurrence of species of genera such as *Achromadora, Tripyla, Miconchus, Mylonchulus*, and other species of nematodes.

The high specific and trophic diversity was reflected in higher value of H´spp and H´gen in soil with river banks vegetation. Despite the high taxa and trophic diversity, average Maturity index and Plant parasitic index and their proportions indicated maturity of both natural ecosystems. According to Wasilewska (1995), the H´index as well as taxa richness is much higher in habitats with a more diverse plant community, what corresponds with our results mainly in case of richness of taxa in river banks. Relatively high PPI with its balance within localities of both ecosystems is joined with a high abundance sometimes a few individual nematode species, which occurrence can be associated with stable richer plants root systems of both investtigated ecosystems, which grant higher status of nutrition for nematodes. In comparison with the PPI from cultivated ecosystems, where according to Háněl (2003) in cultivated soil with wheat PPI = 2.56 and in cultivated soil with cereals according to Valocká *et al.* (2001) PPI ranged 2.61 – 2.84. In natural vegetation of both ecosystems investigated the value of PPI was higher, which means that the soil environment of these ecosystems is more suitable for plant parasitic nematodes. The ratio B/F indicates dominant way in which the breakdown of organic matter in soil proceeds (Wasilewska, 1997) a higher value of this ratio indicates decomposting of organic matter with participation of bacteria in both ecosystems studied.

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