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Diversity of soil nematodes in meadows of the White Carpathians

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Summary

Soil nematodes were studied in 11 meadow sites in the White Carpathians. In total, 155 species and 86 genera were found but the composition of nematode assemblages in eastern and western side of the mountains differed. Most nematode species belonged to the orders Tylenchida (52), Dorylaimida (35) and Rhabditida (16), and to the trophic groups bacterivores (47), plant parasites (29) and omnivores (25). In individual sites and sampling dates the number of species varied in range 18 – 68, genera 18 – 52, H'spp 1.32 – 3.50, H'gen 1.31 – 3.21, T 1.79 – 5.70, MI 2.32 – 3.63, PPI 2.03 – 2.98, and ΣMI 2.20 – 3.50. Composition of nematode assemblages and their matrix classification indicated a low degree of anthropogenous disturbance to the meadows.

Key words: Nematoda; diversity; trophic groups; grassland; meadow

Introduction

Nematodes are important group of soil animals that influence processes in European grasslands (Ekschmitt *et al.*, 2001). In Central Europe, greater part of meadows was established by human activity. Diversity of soil nematodes in meadows may be greater than in (sub) climax forests (Háněl, 1995), nevertheless, can be affected by meadow management (Yeates & Bongers, 1999). The nematode fauna in the White Carpathians is practically unknown, therefore meadows on this territory were included in the project aimed at study of grassland nematodes in the Czech Republic and the Slovak Republic. The goal of this paper is to study diversity soil nematodes in selected meadow habitats and evaluate community indices that are used to characterize nematode communities.

Material and Methods

Nematodes were studied in seven localities of the White Carpathians.

Locality Vrbovce & Vrbovce-Šance, 360 m a.s.l., 48°47´ N, 17°28´ E, gravely loam soil, samples taken in three sites:
1: old meadow, moderately mown; pH (H_2O) 7.00, C_{ox} 5.22 %; plant cover: *Acetosa pratensis* Mill., *Trifolium* L., *Achillea* L., *Cirsium arvense* (L.), *Festuca rubra* L., *Agrostis* L. and others; sampling date: October 2004.
2: meadow on previously arable soil, mown; pH (H_2O) 5.30, C_{ox} 4.37 %; plant cover: *Plantago lanceolata* L., *Dactylis glomerata* L., *F. rubra* L., *Trifolium* L., *Agrostis* L. and others; sampling date: October 2004.
3: pasture meadow; pH (H_2O) 7.06, C_{ox} 6.16 %; plant cover: *Senecio* L., *Brachypodium* P. Beauv., *P. lanceolata* L., *D. glomerata* L., *Trifolium repens* L., *T. pratense* L., *Taraxacum officinale* Web. in Wiggers and others; sampling date: October 2004.

Locality Bošaca, 235 m a.s.l., 48º49' N, 17º49' E, loamy sand soil, samples taken in two sites:
4: original meadow, recently mown; pH (H_2O) 8.86, C_{ox} 5.91 %; plant cover: *Agrimonia eupatoria* L., *Festuca* L., *Arrhenatherum elatius* (L.) P. Beauv., *Fragaria vesca* L. and others.
5: pasture meadow; pH (H_2O) 7.82, C_{ox} 6.58 %; plant cover: *Ononis spinosa* L., *Festuca* L., *Dactylis* L., *Agros-tis* L. and others; sampling date: October 2004.

Locality Hrabovka, 260 m a.s.l., 49º07' N, 18º18' E, loam soil, samples taken in one site:
6: pasture meadow; pH (H_2O) 7.15, C_{ox} 3.15 %; plant cover: *T. officinale* Web. in Wiggers, *Cichorium intybus* L., *Acetosa pratensis* Mill, *Vicia* L., *E. repens* (L.) Desv._and others; sampling date: October 2004.

Locality Vršatecké podhradie, 553 m a.s.l., 49º04' N, 18º08' E, loam soil and clay loam soil, samples taken in two sites:
7: pasture meadow; loam soil, pH (H_2O) 8.96, C_{ox} 4.44 %; plant cover: *E. repens* (L.) Desv., *Potentilla* L., *Myurella tenerrima* (Brid.) Lindb., *C. arvense* (L.) Scop., *P. lanceolata* L., *Senecio* L. and others; sampling date: October

2004.
8: original meadow; clay loam soil, pH (H_2O) 7.82, C_{ox} 5.05 %; plant cover: *A. elatius* (L.) P. Beauv. ex J. Presl et C. Presl, *Brachypodium* P. Beauv., *E. repens* (L.), *Potentil-la* (L.), *C. arvense* (L.) Scop. and others; sampling date: October 2004.

Locality Červený kameň, 335 m a.s.l., 49º04' N, 18º10' E, clay loam soil, samples taken in one site:
9: intensively managed meadow, mown: pH (H_2O) 7.66, C_{ox} 5.78 %; plant cover: *F. rubra* L., *A. stolonifera* L., *Lo-lium perenne* L., *E. repens* (L.) Desv. and others; sampling date: October 2004.

Locality Mikušovce, 350 m a.s.l., 49º04' N, 18º13' E, loa-my sand soil, samples taken in one site:
10: meadow with solitary trees; pH (H_2O) 8.88, C_{ox} 4.27 %; plant cover: *F. rubra* L., *A. elatius* (L.) P. Beauv. ex J. Presl et C. Presl, and others with solitary of *Malus* Mill.; sampling date: October 2004.

Locality Čertoryje (samples C1 – C7), National Nature Re-serve, 370 m a.s.l., 48º54' N, 17º25' E, clay-loam soil, pH (H_2O) 5.30, C_{ox} 4.37 %; plant cover: a species-rich sub-thermophilous meadow of the association Brachypodio-Molinietum Klika 1939, dominant plants mainly grasses such as *Bromus erectus* Huds., *Brachypodium pinnatum* (L.) P. Beauv., *Molinia arundinacea* Schrank, *Festuca ru-picola* Heuffel, sedge *Carex montana* L. accompanied by herbs *Potentilla alba* L., *Cirsium pannonicum* (L.) Link, *Viola hirta* L., *Astragalus danicus* Retz., *Polygala major* Jacq., *Filipendula vulgaris* Moench, *Geranium sengui-neum* L., *Centaurea scabiosa* L., *Serratula tinctoria* L., *Salvia pratensis* L., and others with solitary and small groups of *Quercus robur* L. trees and various shrubs; sam-pling dates: 16 November 1999 (C1), 23 May 2000 (C2), 5 September 2000 (C3), 14 November 2000 (C4), 9 May 2001 (C5), 4 September 2001 (C6), and 12 November 2001 (C7). Details see in Háněl (2003).

Nematodes were isolated from four 10-g sub-samples of the mixed wet soil using modified Baermann funnels, killed and fixed in 3 % formaldehyde and studied in glycerine slides. Data in Table 1 express nematode individuals in 40 g of soil.
Nematode species were allocated to trophic and c-p groups according to Yeates *et al.* (1993) and Bongers (1990). Community indices were calculated as suggested by Freck-man and Ettema (1993) and Yeates and Bongers (1999): Shannon Index (H'spp, H'gen and H'tg calculated for spe-cies, genera and trophic groups, respectively; with natural logarithm), richness Margalef Index (SR for species, GR for genera), Simpson Index (Dspp for species, Dgen for genera), Trophic Diversity Heip's *et al.* (1988) Index (T for trophic groups), Maturity Index (MI), Plant Parasite In-dex (PPI; all species of the order Tylenchida and the plant-parasitic Dorylaimida included), and Σ Maturity Index (ΣMI). Channel Index (CI), Enrichment Index (EI) and Structure Index (SI) were calculated according to Ferris *et al.* (2001) with weightings of nematode taxa as suggested by the authors. The weightings for the taxa not included in the paper were derived from c-p values by Bongers (1990). Statistical calculations were performed using the STATIS-TICA (StatSoft, 2001).

Table 1. Population densities (individuals in 40 g of fresh soil) of soil nematode species in the White Carpathians: mean density (mean), standard deviation (SD, n = 17), dominance (D[%]), frequency of occurrence (F[%]); TG – trophic groups bacterivores (B), fungivores (F), root-fungal feeders (RFF), plant parasites (PP), omnivores (O), predators (P), insect parasites (IP)

No.	TG	c-p	Species in orders	mean	SD	D[%]	F[%]
			MONHYSTERIDA				
1	B	1	*Eumonhystera longicaudatula* (Gerlach et Riemann, 1973)	0.1	0.5	0.04	5.88
2,3	B	1	*Geomonhystera australis* (Cobb, 1893) & *villosa* (Bütschli, 1873)	0.5	1.2	0.18	23.53
4	B	1	*Monhystrella cf paramacrura* (Meyl, 1953)	0.4	1.2	0.13	11.76
5	B	1	*Theristus sp.*	0.2	0.5	0.07	11.76
			CHROMADORIDA				
6	B	3	*Achromadora ruricola* (de Man, 1880)	0.1	0.2	0.02	5.88
7	B	3	*Prodesmodora arctica* (Mulvey, 1969)	0.1	0.3	0.04	11.76
			ARAEOLAIMIDA				
8	B	2	*Cylindrolaimus communis* de Man, 1880	0.2	0.4	0.07	17.65
9	B	2	*Anaplectus granulosus* (Bastian, 1865)	3.5	4.4	1.33	52.94
10	B	2	*Plectus acuminatus* Bastian, 1865	1.2	1.9	0.47	41.18
11	B	2	*Plectus communis* Bütschli, 1873	0.4	0.8	0.16	23.53
12	B	2	*Plectus geophilus* de Man, 1880	0.1	0.3	0.04	11.76
13	B	2	*Plectus opisthocirculus* Andrássy, 1952	0.5	2.2	0.20	5.88
14	B	2	*Plectus parietinus* Bastian, 1865	2.2	2.4	0.84	88.24
15	B	2	*Plectus parvus* Bastian, 1865	0.4	1.1	0.16	17.65
16	B	2	*Plectus rhizophilus* de Man, 1880	0.5	1.3	0.20	23.53

17	B	2	*Plectus thornei* Rühm, 1956	0.5	1.9	0.20	11.76
18	B	2	*Ceratoplectus armatus* (Bütschli, 1873)	0.4	0.7	0.13	23.53
19	B	2	*Tylocephalus auriculatus* (Bütschli, 1873)	0.2	0.7	0.07	5.88
20	B	2	*Tylocephalus laticollis* Zell, 1985	0.1	0.2	0.02	5.88
21	B	2	*Wilsonema otophorum* (de Man, 1880)	0.1	0.2	0.02	5.88
			TERATOCEPHALIDA				
22	B	3	*Metateratocephalus crassidens* (de Man, 1880)	0.1	0.3	0.04	11.76
			RHABDITIDA				
23	B	2	*Heterocephalobus elongatus* (de Man, 1880)	4.0	13.2	1.51	29.41
24	B	2	*Cephalobus persegnis* Bastian, 1865	10.1	12.9	3.82	82.35
25	B	2	*Eucephalobus mucronatus* (Kozlowska et Roguska-Wasilewska, 1963)	0.9	1.2	0.33	41.18
26	B	2	*Eucephalobus oxyuroides* (de Man, 1876)	2.9	5.5	1.09	52.94
27	B	2	*Eucephalobus striatus* (Bastian, 1865)	3.5	6.3	1.33	64.71
28	B	2	*Acrobeloides nanus* (de Man, 1880)	9.6	9.3	3.62	76.47
29	B	2	*Chiloplacus propinquus* (de Man, 1921)	0.4	1.2	0.16	17.65
30	B	2	*Chiloplacus symmetricus* (Thorne, 1925)	0.4	1.2	0.16	11.76
31	B	2	*Cervidellus neftasiensis* Boström, 1986	0.1	0.2	0.02	5.88
32	B	1	*Panagrolaimus rigidus* (Schneider, 1866)	6.1	15.7	2.31	41.18
33	B	1	*Rhabditis cf. terricola* Dujardin, 1845	12.9	14.9	4.86	88.24
34	B	1	*Bursilla monhystera* (Bütschli, 1873)	1.1	2.9	0.40	23.53
35	B	1	*Diploscapter cf coronatus* (Cobb, 1893)	0.4	1.2	0.13	11.76
36	IN	1	*Heterorhabditis sp. juvs.*	0.2	0.7	0.07	5.88
37	IN	1	*Steinernema affine* (Bovien, 1937)	0.2	0.7	0.07	5.88
38	IN	1	*Steinernema juvs.*	0.2	0.6	0.09	17.65
			APHELENCHIDA				
39	F	2	*Aphelenchus avenae* Bastian, 1865	6.8	7.6	2.55	88.24
40	F	2	*Paraphelenchus pseudoparietinus* Micoletzky, 1922	1.2	2.5	0.44	23.53
41	F	2	*Aphelenchoides bicaudatus* (Imamura, 1931)	0.7	2.0	0.27	23.53
42	F	2	*Aphelenchoides composticola* Franklin, 1957	0.7	1.1	0.27	35.29
43	F	2	*Aphelenchoides curiolis* Gritsenko, 1971	6.5	11.4	2.44	41.18
44	F	2	*Aphelenchoides saprophilus* Franklin, 1957	1.4	2.7	0.53	29.41
45	F	2	*Aphelenchoides spicomucronatus* Truskova, 1973	0.8	1.5	0.31	35.29
46	F	2	*Aphelenchoides sp.*	0.3	0.8	0.11	11.76
			TYLENCHIDA				
47	RFF	2	*Psilenchus hilarulus* de Man, 1921	0.2	0.5	0.07	11.76
48	RFF	2	*Basiria gracilis* (Thorne, 1949)	0.5	0.9	0.18	23.53
49	RFF	2	*Basiria graminophila* Siddiqi, 1959	0.1	0.5	0.04	5.88
50	RFF	2	*Boleodorus thylactus* (Thorne, 1941)	3.2	6.3	1.22	35.29
51	RFF	2	*Neopsilenchus magnidens* (Thorne, 1949)	0.8	1.4	0.31	35.29
52	RFF	2	*Filenchus discrepans* (Andrássy, 1954)	0.2	0.6	0.09	17.65
53	RFF	2	*Filenchus filiformis* (Bütschli, 1873) – *vulgaris* (Brzeski, 1963)	5.5	5.3	2.09	88.24
54	RFF	2	*Filenchus hamatus* (Thorne et Malek, 1968)	0.1	0.5	0.04	5.88
55	RFF	2	*Filenchus longicaudatulus* Zell, 1988	0.2	0.5	0.07	11.76
56	RFF	2	*Filenchus misellus* (Andrássy, 1958)	35.6	59.2	13.45	41.18
57	RFF	2	*Filenchus polyhypnus* (Steiner et Albin, 1946)	0.2	0.7	0.07	5.88
58	RFF	2	*Filenchus sp.*	0.1	0.3	0.04	11.76
59	RFF	2	*Tylenchus davainei* Bastian, 1865	0.1	0.2	0.02	5.88
60	RFF	2	*Tylenchus elegans* de Man, 1876	0.1	0.2	0.02	5.88
61	RFF	2	*Tylenchus sp. juvs.*	0.4	0.9	0.13	17.65
62	RFF	2	*Miculenchus salvus* Andrássy, 1959	0.1	0.2	0.02	5.88
63	RFF	2	*Malenchus andrassyi* Merny, 1970	0.1	0.2	0.02	5.88
64	RFF	2	*Malenchus cognatus* Andrássy, 1981	0.1	0.5	0.04	5.88
65	RFF	2	*Malenchus exiguus* (Massey, 1969)	0.6	2.0	0.24	17.65
66	RFF	2	*Coslenchus alacinatus* Siddiqi, 1981	0.6	1.7	0.24	23.53
67	RFF	2	*Coslenchus costatus* (de Man, 1921)	0.6	1.2	0.22	23.53
68	RFF	2	*Aglenchus agricola* (de Man, 1884)	4.6	8.4	1.75	52.94

69	F	2	*Ditylenchus acutus* (Khan, 1965)	0.3	0.8	0.11	11.76
70	F	2	*Ditylenchus medicaginis* Wasilewska, 1965	2.8	3.8	1.04	41.18
71	F	2	*Nothotylenchus acris* Thorne, 1941	0.1	0.5	0.04	5.88
72	PP	2	*Bitylenchus dubius* (Bütschli, 1873)	2.1	3.7	0.78	41.18
73	PP	3	*Tylenchorhynchus cylindricus* Cobb, 1913	0.8	2.2	0.31	23.53
74	PP	3	*Tylenchorhynchus sp. juvs.*	0.2	0.5	0.07	11.76
75	PP	3	*Amplimerlinius globigerus* Siddiqi, 1979	0.9	3.4	0.33	11.76
76	PP	3	*Amplimerlinius macrurus* (Goodey, 1932)	5.0	20.1	1.89	11.76
77	PP	3	*Trophurus sculptus* Loof, 1956	0.8	2.1	0.31	17.65
78	PP	3	*Rotylenchus goodeyi* Loof et Oostenbrink, 1958	0.5	1.2	0.18	17.65
79	PP	3	*Rotylenchus robustus* (de Man, 1876)	0.3	1.0	0.11	11.76
80	PP	3	*Helicotylenchus canadensis* Waseem, 1961	4.9	9.3	1.86	47.06
81	PP	3	*Helicotylenchus digonicus* Perry in Perry, Darling et Thorne, 1959	26.2	61.1	9.87	58.82
82	PP	3	*Helicotylenchus pseudorobustus* (Steiner, 1914)	0.2	0.7	0.09	11.76
83	PP	3	*Helicotylenchus vulgaris* Yuen, 1964	0.2	0.5	0.07	11.76
84	PP	3	*Pratylenchus crenatus* Loof, 1960	0.5	0.9	0.20	29.41
85	PP	3	*Pratylenchus pratensis* (de Man, 1880)	1.1	2.3	0.42	29.41
86	PP	2	*Paratylenchus bukowinensis* Micoletzky, 1922	2.1	5.2	0.78	23.53
87	PP	2	*Paratylenchus goodeyi* Oostenbrink, 1953	0.1	0.5	0.04	5.88
88	PP	2	*Paratylenchus microdorus* Andrássy, 1959	0.2	1.0	0.09	5.88
89	PP	2	*Paratylenchus similis* Khan, Prasad et Mathur, 1967	0.1	0.2	0.02	5.88
90	PP	2	*Paratylenchus steineri* Golden, 1961	0.9	2.1	0.33	23.53
91	PP	2	*Paratylenchus straeleni* (de Coninck, 1931)	0.4	1.7	0.16	5.88
92	PP	2	*Paratylenchus sp.1*	0.1	0.5	0.04	5.88
93	PP	2	*Paratylenchus sp.2 juvs.*	0.4	1.3	0.16	11.76
94	PP	3	*Criconemoides parvus* Raski, 1952	0.4	1.7	0.16	5.88
95	PP	3	*Sphaeronema juvs.*	0.9	2.3	0.36	17.65
96	PP	3	*Xenocriconemella macrodora* (Taylor, 1936)	0.4	1.0	0.16	17.65
97	PP	3	*Mesocriconema antipolitanum* (de Guiran, 1963)	0.2	0.4	0.07	17.65
98	PP	3	*Mesocriconema rusticum* (Micoletzky, 1915)	0.1	0.5	0.04	5.88
			ENOPLIDA				
99	B	3	*Bastiania gracilis* de Man, 1876	0.8	2.0	0.31	29.41
100	B	3	*Odontolaimus chlorurus* de Man, 1880	0.4	0.9	0.13	17.65
101	P	3	*Tripyla filicaudata* de Man, 1880	2.0	5.6	0.75	23.53
102	P	3	*Tripyla setifera* Bütschli, 1873	0.4	1.0	0.16	23.53
103	B	3	*Prismatolaimus dolichurus* de Man, 1880	0.1	0.2	0.02	5.88
104	B	3	*Prismatolaimus intermedius* (Bütschli, 1873)	1.8	3.9	0.69	41.18
105	B	3	*Prismatolaimus matoni* Mulk et Coomans, 1979	0.4	1.2	0.13	11.76
106	B	3	*Aulolaimus nannocephalus* Andrássy, 1972	0.1	0.2	0.02	5.88
			ALAIMIDA				
107	B	4	*Alaimus arcuatus* Thorne, 1939	0.1	0.2	0.02	5.88
108	B	4	*Alaimus meyli* Andrássy, 1961	0.1	0.2	0.02	5.88
109	B	4	*Alaimus primitivus* de Man, 1880	1.4	3.6	0.53	35.29
110	B	4	*Paramphidelus dolichurus* (de Man, 1876)	0.2	0.7	0.07	5.88
111	B	4	*Paramphidelus pseudobulbosus* (Altherr, 1953)	0.1	0.2	0.02	5.88
112	B	4	*Paramphidelus pusillus* (Thorne, 1936)	0.1	0.5	0.04	5.88
			MONONCHIDA				
113	P	4	*Clarkus papillatus* (Bastian, 1865)	1.2	2.0	0.44	35.29
114	P	4	*Coomansus parvus* (de Man, 1880)	2.8	4.3	1.07	52.94
115	P	4	*Mononchus aquaticus* Coetzee, 1968	0.1	0.5	0.04	5.88
116	P	4	*Prionchulus punctatus* Cobb, 1917	1.2	2.1	0.44	29.41
117	P	4	*Mylonchulus brachyuris* (Bütschli, 1873)	2.4	6.2	0.91	29.41
118	P	4	*Mylonchulus sigmaturus* (Cobb, 1917)	1.9	2.8	0.73	41.18
119	P	4	*Anatonchus tridentatus* (de Man, 1876)	3.0	4.0	1.13	64.71
			DORYLAIMIDA				
120	O	4	*Dorylaimus stagnalis* Dujardin, 1845	1.0	4.1	0.38	5.88

121	O	5	*Prodorylaimus acris* (Thorne, 1936)	1.2	3.7	0.44	17.65
122	O	5	*Mesodorylaimus aduncus* Andrássy, 1986	0.2	1.0	0.09	5.88
123	O	5	*Mesodorylaimus bastiani* (Bütschli, 1873)	2.3	5.2	0.87	41.18
124	O	5	*Mesodorylaimus centrocercus* (de Man, 1880)	0.9	3.4	0.33	11.76
125	O	5	*Mesodorylaimus meyli* Andrássy, 1958	0.2	0.6	0.09	17.65
126	O	5	*Aporcelaimellus obtusicaudatus* (Bastian, 1865)	6.1	5.9	2.29	82.35
127	O	5	*Paraxonchium laetificans* (Andrássy, 1956)	0.4	1.1	0.13	11.76
128	O	4	*Eudorylaimus carteri* (Bastian, 1865)	2.2	5.6	0.82	35.29
129	O	4	*Eudorylaimus confusus/longicardius* Thorne, 1974	1.0	2.5	0.38	29.41
130	O	4	*Eudorylaimus leuckarti* (Bütschli, 1973)	0.2	1.0	0.09	5.88
131	O	4	*Eudorylaimus spp. juvs.*	4.6	5.5	1.73	64.71
132	O	4	*Microdorylaimus longicollis* (Brzeski, 1964)	0.5	2.2	0.20	5.88
133	O	4	*Microdorylaimus parvus* (de Man, 1880)	0.1	0.5	0.04	5.88
134	O	4	*Allodorylaimus granuliferus* (Cobb, 1893)	2.9	6.0	1.09	41.18
135	O	4	*Thonus ettersbergensis* (de Man, 1885)	1.2	1.3	0.47	58.82
136	PP	4	*Longidorella microdora* (de Man, 1880)	0.5	1.9	0.18	5.88
137	O	4	*Pungentus engadinensis* (Altherr, 1950)	0.1	0.2	0.02	5.88
138	O	4	*Pungentus silvestris* (de Man, 1912)	2.9	4.8	1.11	52.94
139	O	4	*Enchodelus macrodorus* (de Man, 1880)	5.3	7.0	2.00	58.82
140	O	4	*Enchodelus (Paraenchodelus) sp.*	0.1	0.5	0.04	5.88
141	PP	5	*Longidorus elongatus* (de Man, 1876)	0.1	0.5	0.04	5.88
142	O	5	*Axonchium cf. deconincki* Nair, 1975	1.1	1.7	0.40	35.29
143	O	5	*Axonchium coronatum* (de Man, 1906)	2.0	5.4	0.75	29.41
144	O	5	*Axonchium nairi* Altherr, 1974	1.1	3.3	0.40	11.76
145	O	5	*Oxydirus oxycephalus* (de Man, 1885)	5.8	5.1	2.17	76.47
146	F	4	*Tylencholaimus constrictus* Vinciguerra, 1986	5.9	19.1	2.24	29.41
147	F	4	*Tylencholaimus minutus* Vinciguerra, 1986	0.1	0.5	0.04	5.88
148	F	4	*Tylencholaimus mirabilis* (Bütschli, 1873)	0.5	1.5	0.18	11.76
149	F	4	*Tylencholaimus sp. juvs.*	0.1	0.5	0.04	5.88
150	F	4	*Tylencholaimellus striatus* Thorne, 1939	0.1	0.5	0.04	5.88
151	O	4	*Dorylaimoides micoletzkyi* (de Man, 1921)	0.6	1.8	0.24	11.76
152	P	5	*Nygolaimus trophurus* Heyns, 1968	0.1	0.3	0.04	11.76
153	P	5	*Paravulvus hartingii* (de Man, 1880)	0.3	0.7	0.11	17.65
154	P	5	*Paravulvus acuticaudatus* (Thorne, 1930)	0.1	0.2	0.02	5.88
			TRIPLONCHIDA				
155	F	3	*Diptherophora communis* de Man, 1880	2.6	4.3	1.00	52.94
			Total nematodes	265.1	172.7	100	100

Results

In the meadows studied, 155 species and 86 genera of nematodes in the total material of 4 507 individuals were found (Table 1). In the Čertoryje, for the whole period of the investigations there was found 119 species and 79 genera with H'spp = 3.64 and H'gen = 3.31. Most nematodes belonged to the orders Tylenchida (52 species and 1 824 individuals), Dorylaimida (35 and 888) and Rhabditida (16 and 899). Bacterivores were represented by 47 species and 1 180 individuals followed by plant parasites (29 species and 861 individuals), omnivores (25 and 747), root-fungal feeders (22 and 919), fungivores (17 and 526), predators (12 and 264), and insect parasites (3 and 10).

Table 2 shows the values of community indices in the sites studied and Table 3 gives Pearson correlation coefficient between these indices. The number of nematode species at individual sites and sampling dates varied from 18 to 68, the number of genera from 18 to 52. Values of diversity indices (richness, H', D) for species as well as for genera reached high values, except for the locality 10 with predominance of *Helicotylenchus digonicus*. The high values were also found for trophic diversity indices H'tg and T (exception the locality 10). The values of MI, PPI and ΣMI were always greater than 2 whereas the ratio PPI/MI equaled or decreased less than 1. Maturity Index had no significant correlation with any diversity index, PPI and ΣMI showed some significant negative correlations with diversity indices. PPI/MI ratio showed no significant correlation with any community index.

CI values were high except for some sites (5, 7, 9). EI values were significantly negatively correlated with CI values ($r = -0.72$, $p = 0.001$) and these two indices showed no significant correlation with any other community index. SI values were high in all sites and were significantly positively correlated with values of MI ($r = 0.76$, $P < 0.001$) and

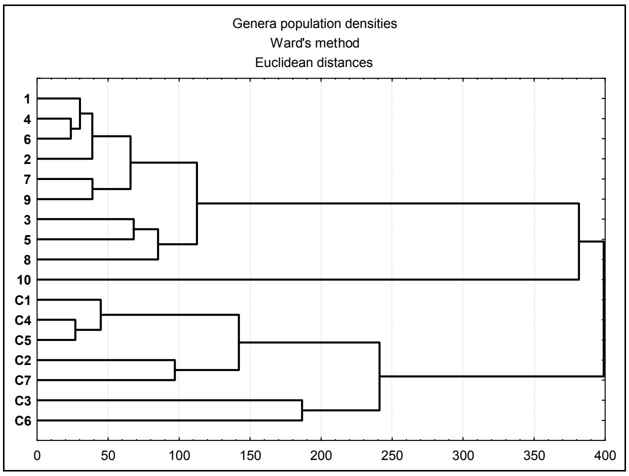

Fig. 1. Cluster analysis of soil nematodes in meadows of the White Carpathians

with ΣMI (r = 0.71, p = 0.002) but gave no significant correlation with other indices.

Cluster analysis performed on genera population densities (Fig. 1) showed sites on the eastern side of the White Carpathians clearly separated from the group of samples taken in the Čertoryje meadow on the western side. Position of the site 10 was influenced by a high population of *Helicotylenchus digonicus*.

Discussion

The number of nematode species in the meadows of the study area was high. For example, Šály (1985) found 96 species in meadows and pastures of the Slovak Paradise and 182 species in its whole territory. Lišková and Čerevková (2005) found 69 species and 48 genera of soil nematodes in five meadow habitats in Slovakia and Zolda (2002)

Table 2. Community indices of soil nematodes in meadows of the White Carpathians, for the Čertoryje meadow mean, ± S.D. (n = 7), and range of values are given

	1	2	3	4	5	6	7	8	9	10	Čertoryje (C1 – C7)	
Number of individuals	88	144	203	70	328	129	189	285	120	355	370.86 ± 205.34	(130 – 636)
Number of species	18	26	32	23	31	30	27	25	21	20	52.71 ± 13.16	(38 – 68)
Species richness SR	3.80	5.03	5.83	5.18	5.18	5.97	4.96	4.25	4.18	3.24	8.89 ± 1.51	(7.60 – 10.32)
H'spp (with ln)	2.49	2.93	2.89	2.92	2.98	2.99	2.62	2.68	2.58	1.32	3.14 ± 0.24	(2.71 – 3.50)
Dspp	9.38	14.73	12.03	15.61	14.98	15.01	9.08	11.13	8.82	1.91	12.60 ± 4.67	(6.15 – 20.86)
Number of genera	18	23	26	22	27	26	24	22	20	19	41.14 ± 9.63	(30 – 52)
Genus richness GR	3.80	4.43	4.71	4.94	4.49	5.14	4.39	3.72	3.97	3.07	6.91 ± 1.11	(5.96 – 8.44)
H'gen (with ln)	2.49	2.79	2.69	2.82	2.84	2.88	2.57	2.59	2.52	1.31	2.88 ± 0.21	(2.54 – 3.21)
Dgen	9.38	13.06	10.66	13.32	13.18	14.16	9.01	10.65	8.61	1.91	9.84 ± 3.39	(5.72 – 15.63)
H' tg (with ln)	1.36	1.80	1.51	1.64	1.56	1.55	1.44	1.53	1.35	0.92	1.62 ± 0.10	(1.43 – 1.74)
T	3.28	5.70	3.73	4.69	4.23	4.27	3.59	4.06	3.27	1.79	4.44 ± 0.57	(3.62 – 5.44)
MI	3.63	3.25	2.54	3.21	2.93	3.04	2.58	3.14	3.05	3.57	2.79 ± 0.33	(2.32 – 3.28)
PPI	2.94	2.46	2.34	2.64	2.48	2.85	2.61	2.83	2.42	2.98	2.20 ± 0.15	(2.03 – 2.45)
∑MI	3.50	2.94	2.46	3.03	2.76	2.97	2.59	3.08	2.98	3.13	2.51 ± 0.21	(2.20 – 2.85)
PPI/MI	0.81	0.75	0.92	0.82	0.85	0.94	1.01	0.90	0.79	0.83	0.79 ± 0.08	(0.66 – 0.92)
CI	40.7	11.1	16.7	42.9	2.3	23.8	7.0	70.0	2.3	55.6	27.1 ± 9.5	(15.9 – 45.9)
EI	57.5	71.1	22.2	26.9	57.7	56.0	80.4	24.8	89.7	24.3	61.6 ± 11.1	(45.1 – 80.5)
SI	93.2	92.0	68.8	87.7	89.4	86.5	85.1	82.7	95.5	92.8	81.5 ± 6.4	(74.5 – 89.9)

Table 3. Person correlation coefficients between community indices of nematodes at individual sites and sampling dates, n = 17, * P < 0.05, ** P < 0.01, *** P < 0.001

	Species	SR	H'spp	Dspp	Genera	GR	H'gen	Dgen	H'tg	T	MI	PPI	∑MI
Individuals	$+0.76^{***}$	$+0.61^{**}$	+0.12	-0.05	$+0.75^{***}$	$+0.55^{*}$	+0.06	-0.13	+0.01	+0.05	-0.23	-0.25	-0.34
Species		$+0.98^{***}$	$+0.62^{**}$	+0.32	$+0.99^{***}$	$+0.95^{***}$	$+0.54^{*}$	+0.15	+0.46	+0.42	-0.37	-0.59^{*}	-0.56^{*}
SR			$+0.72^{**}$	+0.40	$+0.97^{***}$	$+0.99^{***}$	$+0.63^{**}$	+0.21	$+0.56^{*}$	$+0.50^{*}$	-0.39	-0.66^{**}	-0.59^{*}
H'spp				$+0.81^{***}$	$+0.62^{**}$	$+0.73^{***}$	$+0.98^{***}$	$+0.71^{**}$	$+0.91^{***}$	$+0.82^{***}$	-0.46	-0.59^{*}	-0.47
Dspp					+0.30	+0.40	$+0.83^{***}$	$+0.95^{***}$	$+0.78^{***}$	$+0.77^{***}$	-0.26	-0.16	-0.14
Genera						$+0.96^{***}$	$+0.54^{*}$	+0.14	+0.46	+0.41	-0.32	-0.57^{*}	-0.52^{*}
GR							$+0.65^{**}$	+0.23	$+0.58^{*}$	$+0.52^{*}$	-0.32	-0.63^{**}	-0.52^{*}
H'gen								$+0.79^{***}$	$+0.91^{***}$	$+0.83^{***}$	-0.41	-0.48^{*}	-0.36
Dgen									$+0.72^{**}$	$+0.73^{***}$	-0.16	+0.03	+0.03
H'tg										$+0.97^{***}$	-0.29	-0.48^{*}	-0.32
T											-0.18	-0.38	-0.21
MI												$+0.67^{**}$	$+0.90^{***}$
PPI													$+0.86^{***}$

determined 21 genera in the rhizosphere of meadows in the National Park See Neusiedl-Seewinkel in Austria. In Spain, Dmowska (2000) identified 140 nematode species from 71 genera in the rhizosphere of subalpine meadows and evaluated the dominance of nematode taxa according to different soil types and climates of the investigated regions of Pyrenees. Hodda and Wanless (1994) recorded 154 nematode species in English chalk grasslands. Wasilewska (2002) identified 122 genera of soil nematodes on fen peat meadows in Biebrza Wetlands in Poland over a long period of investigation since 1978 to 1997. As seen, the number of species and genera vary with site and time. In the Čertoryje meadow the mean number of species on individual sampling dates represented 45 % of all species found in the locality. In four different ecosystems studied by Háněl (1995) the mean number of species over sampling dates in individual years varied from 45 % to 63 % of the year total. We can infer that one-date sampling can reveal about a half of the total soil nematode species in a locality; in genera the proportion can be greater.

This is in agreement with Table 3 where the number of individuals is significantly positively correlated with the number of species and genera as well as SR and GR. On the other hand, other diversity indices showed low insignificant correlations with number of individuals. H'spp was significantly positively correlated with all diversity indices as well as H'gen and both can be used for evaluation of heterogeneity of a nematode assemblage. H'tg and T changed in similar way being little affected by the number of individuals, species and genera. Therefore, the number of species & H'spp (genera & H'gen) together with T can be sufficient for characterization of taxonomic and trophic diversity of a nematode assemblage; taking into consideration that the number of species (genera) can be influenced by the number of individuals studied. For this reason the number of nematode individuals determined should be also provided.

MI was negatively but insignificantly correlated with diversity indices, but the respective correlations for PPI were mostly negative significant, which affected results obtained for ΣMI (which includes PPI taxa). Explanation of this phenomenon is problematic. In succession studied by Háněl (1995) MI was positively correlated with the number of species, H'spp and H'gen whereas PPI was correlated negatively with these diversity indices. The diversity of soil nematodes in succession increased but simultaneously with increase in populations of Tylenchidae with c-p 2, which decreased the values of PPI. At least some *Filenchus* species (such as *F. misellus* and *F. discrepans*) are fungivorous and their high population densities can affect the results of nematode community analyses (Okada *et al.* 2005).

PPI/MI ratio was lower or equal to 1, which according to Bongers *et al.* (1997) indicates natural habitats, where plants make optimal use of nutrient resources or only slight nutrient disturbances. Generally high values of CI also indicated dominance of fungal pathways in decomposition food webs in the meadows studied and their undisturbed conditions (Bardgett & McAlister, 1999). Low CI in the sites 5, 7, and 9 were caused by temporarily high population densities of *Rhabditis*, which occur in patches of the intensive organic matter decay. The values of EI and CI determined position of the sites studied in the quadrants B and C as defined by Ferris *et al.* (2001). The position of sites in these quadrants is and indication of maturing structured-stable soil food-web conditions with low degree of disturbance. Also diversity indices of nematodes varied in similar range on both sides of the White Carpathians.

The high values of MI, SI as well as diversity indicated structured nematode assemblages. However, these assemblages were taxonomically different as shown by cluster analysis (Fig. 1). This implies that a structured-stable food web in soil can be maintained by different species composition of nematodes. Ritz and Trudgill (1999) suggested that studies of nematodes should focus on functional level (trophic groups, r/K strategists ratio, rates of population increase, etc.) rather than at the family, generic or species level, although they mentioned 'key' species/genera and all-taxa biotic inventory. Yeates (2003) stated that allocation of nematodes to trophic and c-p groups is often uncertain and proposed species-level discrimination as necessary to permit further advances in understanding the role of nematodes in the soil. Results of our study suggest that dominant species (genera) in each functional group should be determined. For example, species of the families Tylenchidae and Tylenchulidae are both included in PPI group and c-p value 2. But the family Tylenchidae represents facultative/obligatory plant feeders, which does not cause serious damage to plants whereas species of the family Tylenchulidae can have very negative influence on plant growth. Therefore, interpretation of the same value of PPI can be different and species dependent.

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