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SPATIAL DISTRIBUTION OF NEMATODES IN THE FOREST ECOSYSTEM OF THE MEZIN NATIONAL NATURE PARK, UKRAINE

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Spatial Distribution of Nematodes in the Forest Ecosystem of the Mezin National Nature Park, Ukraine. Zhylina, T. M. & Shevchenko, V. L. — Nematode communities were investigated in the soil, litter and epiphytic moss of natural mesophilic broad-leaved forest in the Mezin National Natural Park. A total of 75 species belonging to 55 genera, 32 families and 10 orders were identified. Results showed that taxonomic diversity of the nematode fauna in the soil was higher than in the litter and epiphytic moss. Soil-inhabiting nematodes were 53 species (43 genera, 27 families), litter nematodes — 42 species (32 genera, 19 families), whereas moss nematodes belonged to 25 species (23 genera, 16 families). The lowest value of Shannon diversity index was recorded in the moss (2.17), while it was the highest in the soil (3.25). In contrast, the abundance in nematode communities was the highest in epiphytic moss (mean value 4621.55 ind./100 g). The lowest nematode abundance (450.12 ind./100 g) was found in the forest soil. *Rhabditis filiformis* Bütschli, 1873 was recorded in the eudominant group in the forest soil (proportion in the community 14.83 %). *Aphelenchoides composticola* Franklin, 1957 (17.79 %), *Mesodorylaimus bastiani* Bütschli, 1873 (13.91 %) and *Plectus cirratus* Bastian, 1865 (15.8 %) were eudominants in the litter, and *Aporcelaimellus paracentrocercus* (de Coninck, 1935) (11.75 %), *P. cirratus* (20.1 %), *Tylencholaimus teres* Thorne, 1939 (35.21 %) in epiphytic moss.
Key words: nematode communities, taxonomic diversity, abundance, microhabitats, Mezin National Nature Park.

Introduction

Nematodes are known to be among the most diverse group on the Earth; some studies estimates for the number of species of nematodes from 100 000 to 1 000 000 species (Luc et al., 2010).

Due to their abundance, free-living nematodes significantly influence ecosystem processes, particularly in the soil (Bongers & Bongers, 1998). They play an important role in ecosystem functioning as soil-inhabiting parasites and pathogens of plants with effects on ecosystem primary productivity and as regulators of decomposition and soil nutrient mineralization, indirectly, through feeding on microorganisms and other soil animals, or directly, by element release through metabolic secretion and other activities (Ferris et al., 1997; Ruess & Ferris, 2004; Ferris, 2010).

Nematode communities are diverse and numerous in forest ecosystems. In forest soil and litter, there are approximately 10 million individuals per m^2 and over 400 species. These communities are useful indicators of the condition of forest ecosystems (Yeates, 2007).

The study of soil nematode communities in forest ecosystems has a long history, and it continues to be a subject of great interest. Studies of the nematode fauna of forest ecosystems carried out at different times mainly concerned particular components: the soil (Poiras, 2006; Lišková et al., 2008; Kozlovsky, 2009; Renčo et al., 2012; Skwiercz, 2012; Zhylina & Shevchenko, 2014), the litter (Krivtsov et al., 2010; Zhylina & Shevchenko, 2022), epiphytic and epilithic mosses (Yeates, 1972; Lazarova et al., 2000; Shevchenko & Zhylina, 2016).

More attention is now paid to local distribution patterns of nematodes and spatio-temporal variation of the diversity of nematode communities in forest ecosystems (Lazarova et al., 2004; Tsiafouli et al., 2017).

Despite the numerous studies performed around the world on the influence of habitat on nematode community, large-scale studies on the diversity of the nematode communities are not always applicable to every geographical region due to the existing variation from region to region and from habitat to habitat. Therefore, local studies on nematode assemblages are considered more reliable and informative. Richness, or the number of taxa occupying a site, is a meaningful and commonly used measure of ecological condition of habitats (Bhusal et al., 2014).

The aim of present study was to describe and compare the taxonomic composition and the nematode community diversity in three microhabitats: the soil, the litter and epiphytic mosses within a natural mesophilic broad-leaved forest.

Material and Methods

Mezin National Natural Park (MNNP) was established by the Order of the President of Ukraine No. 122 on February 10, 2006. It is located in the northern part of the Novhorod-Siverskyi District in the Chernihiv Region.

According to the geobotanical zoning the territory belongs to Novhorod-Siverskyi Ponornytsia region of oak-pine and oak forest and flood meadows of Chernihiv Novhorod-Siverskyi (Eastern Polissia) district of oak-pine and pine forest of the East European Province of the European broad-leaved forest region (Rudenko, 2007). The area of the National Natural Park is 310 km^2; woodlands occupy 38 %. Forest vegetation is represented mainly by oak with the predominant lime-oak and maple-lime-oak forest, in which *Quercus robur* L. always forms the first stage with admixture of other species. *Tilia cordata* Mill. and *Acer platanoides* L. make the second stage. The tree communities are represented by oak, lime-oak, maple-lime-oak, lime, hornbeam-oak ("Rykhlivska Dacha" Landscape Reserve) and ash-tree ("Vyshenska Dacha" Botanical Reserve) subformations. In addition to the natural forest vegetation, there numerous plantations formed by *Populus tremula* L., *Betula pendula* Roth and *Robinia pseudoacacia* L. (Karpenko, 2020).

Soil, litter and epiphytic moss samples were collected during 2008–2014 from MNNP (51°40'40" N, 32°52'07" E). The studied forest ecosystem was the mesophilic broad-leaved forest of the *Carpino–Fagetea sylvaticae* Jakucs ex Passarge 1968 class: *Carpinion betuli* Issler 1931 and *Querco roboris–Tilion cordatae* Solomeshch et Laivinš ex Bulokhov et Solomeshch in Bulokhov et Semenishchenkov 2015. The vegetation syntaxa were identified according to Mucina et al. (2016), Matuszkiewicz (2019).

Three sampling sites, each covering an area of 10 m^2 with typical vegetation, were selected randomly. At each site, three samples of the soil, the litter and epiphytic mosses were collected. Each sample consisted of 10 subsamples, bulked and mixed to form a single sample. Soil samples (down to approximately 10–15 cm depth after removing litter) were taken using a hand spade and at 1 m distance from a tree trunk. Litter samples (leaves and organic matter overlying the soil) were each collected from 15 × 15 cm areas. Moss samples were collected from the trunks of the trees (*Populus tremula* L.) at a height of 100–120 cm.

Nematodes were extracted by a modified Baermann's method. We used 5 g of fragmented litter, 5 g of the moss, or 20 g of the soil. Exposition time was 48 h. Extracted nematodes were fixed in the TAF (2 % triethanolamine, 7 % formaldehyde solution, 91 % water), and mounted on the temporary hydroglyceric slides (Kiryanova & Krall, 1969). A hundred of nematode specimens were randomly selected and identified, while the rest were calculated. In the samples with less than 100 nematodes, all the specimens were identified. Nematodes were examined under the light microscope Delta Optical Genetic Pro and identified to the species level using published keys and descriptions (Goodey, 1963; Kiryanova & Krall, 1969; Nesterov, 1979).

The total number of species (S) and the total number of nematodes (N) in each sample were determined. For every species, we calculated population density (number of individuals in 100 g of substrate) and dominance, D (percentage of specimens of a given species to the total number of nematodes). Five categories of dominance were established: eudominant (Ed) — 10.1 % and more, dominant (Dm) — 5.1–10.0 %, subdominant (Sd) — 2.1–5.0 %, recedent (R) — 1.1–2.0 % and subrecedent (Sr) — less than 1.1 % (Tischler, 1949).

Nematode diversity was compared and described using the following indices: ST — taxonomic wealth index (Emelyanov et al., 1999), J — Jaccard's index of similarity (Jaccard, 1908), H' — Shannon–Wiener index of diversity, M — Menhinick's diversity index (Pesenko, 1982). Mathematical processing of the data was performed using Microsoft Excel "Analysis Pack" and PAST software (Hammer et al., 2001).

Results and Discussion

A total of 75 species belonging to 55 genera, 32 families and 10 orders were identified in the three microhabitats studied in forest ecosystem of the MNNP. The taxonomic composition of nematode communities in the soil, litter and epiphytic moss was different (table 1).

Table 1. List of nematodes identified in the studied microhabitats of forest ecosystem in the MNNP

No	Orders / Families / Species	Presence in habitats		
		Soil	Litter	Moss
	Order Enoplida			
	Family Alaimidae			
1	*Alaimus primitivus* de Man, 1880	+	–	+
	Family Rhabdolaimidae			
2	*Rhabdolaimus terrestris* de Man, 1880	–	+	+
	Order Triplonchida			
	Family Prismatolaimidae			
3	*Prismatolaimus intermedius* Bütschli, 1873	+	+	+
	Family Diphtherophoridae			
4	*Tylolaimophorus typicus* de Man, 1880	+	–	–
	Family Tripylidae de Man, 1876			
5	*Paratripyla* sp.	–	–	+
	Order Dorylaimida			
	Family Aporcelaimidae			
6	*Aporcelaimellus obtusicaudatus* (Bastian, 1865)	+	+	–
7	*Aporcelaimellus paracentrocercus* (de Coninck, 1935)	–	–	+
	Family Dorylaimidae			
8	*Dorylaimus stagnalis* Dujardin, 1845	+	–	–
9	*Mesodorylaimus bastiani* Bütschli, 1873	+	+	+
10	*Mesodorylaimus musae* Geraert, 1962	+	–	–
	Family Qudsianematidae			
11	*Discolaimus major* Thorne, 1939	+	–	–
12	*Ecumenicus monohystera* (de Man, 1880)	+	–	+
13	*Eudorylaimus arcus* (Thorne et Swanger, 1936)	–	+	–
14	*Eudorylaimus carteri* (Bastian, 1865)	+	+	–
15	*Eudorylaimus pratensis* (de Man. 1880)	–	+	–
16	*Eudorylaimus projectus* (Thorne, 1939)	+	–	–
17	*Crassolabium circuliferum* (Loof, 1962)	–	–	+
18	*Crassolabium ettersbergense* (de Man, 1885)	+	–	–

	Family Tylencholaimidae			
19	*Tylencholaimus mirabilis* (Bütschli, 1873)	+	+	–
20	*Tylencholaimus teres* Thorne, 1939	+	+	+
	Family Longidoridae			
21	*Longidorus elongatus* de Man, 1876 Thorne et Swanger, 1936	+	–	–
	Family Belondiridae			
22	*Dorylaimellus* sp.	–	+	–
	Order Araeolaimida			
	Family Diplopeltidae			
23	*Cylindrolaimus communis* de Man, 1880	–	+	–
24	*Cylindrolaimus melancholicus* de Man, 1880	+	–	–
	Order Mononchida			
	Family Mononchidae			
25	*Clarkus papillatus* (Bastian, 1865)	+	+	–
26	*Prionchulus muscorum* (Dujardin, 1845)	–	+	+
	Order Monhysterida			
	Family Monhysteridae			
27	*Geomonhystera villosa* Bütschli, 1873	–	+	+
28	*Eumonhystera vulgaris* de Man, 1880	–	+	+
29	*Monhystera filiformis* Bastian, 1865	+	–	–
	Order Plectida			
	Family Plectidae			
30	*Anaplectus granulosus* (Bastian, 1865)	+	+	+
31	*Plectus assimilis* Butschli, 1873	–	+	–
32	*Plectus cirratus* Bastian, 1865	+	+	+
33	*Plectus parietinus* Bastian, 1865	+	+	+
34	*Plectus parvus* (Bastian, 1865)	+	+	+
35	*Plectus rhizophilus* (de Man, 1880)	+	+	–
36	*Plectus* sp.	+	–	–
37	*Tylocephalus auriculatus* (Bütschli, 1873)	–	+	+
38	*Wilsonema otophorum* (de Man, 1880)	–	+	–
	Order Rhabditida			
	Family Teratocephalidae			
39	*Teratocephalus terrestris* Bütschli, 1873	–	–	+
	Family Cephalobidae Filipjev, 1934			
40	*Acrobeles ciliatus* Von Linstow, 1877	+	–	–
41	*Acrobeloides bűtschlii* (de Man, 1884)	+	+	–
42	*Cephalobus persegnis* Bastian, 1865	+	+	–
43	*Cervidellus cervus* Thorne, 1925	+	+	–
44	*Chiloplacus symmetricus* (Thorne, 1925)	+	+	–
45	*Eucephalobus mucronatus* (Kozlowska et Roguska-Wasilewska, 1963)	+	+	–
46	*Eucephalobus oxyuroides* (de Man, 1880)	+	+	+
	Family Osstellidae Heyns, 1962			
47	*Drilocephalobus moldavicus* Lisethkaja 1968	+	–	–
	Family Panagrolaimidae Thorne, 1937			
48	*Panagrobelus topayi* Andrássy, 1960	–	–	+
49	*Panagrolaimus rigidus* (Schneider, 1866)	+	+	+
	Family Rhabditidae Örley, 1880			
50	*Rhabditis brevispina* (Claus, 1862) Bütschli, 1873	+	–	–
51	*Rhabditis filiformis* Bütschli, 1873	+	–	–
52	*Rhabditis* sp.	+	–	–

	Family Mesorhabditidae			
53	*Mesorhabditis monhystera* (Bütschli, 1873) Dougherty, 1955	+	+	–
54	*Mesorhabditis* sp.	–	+	–
	Order Aphelenchida			
	Family Aphelenchidae			
55	*Aphelenchus avenae* Bastian, 1965	+	–	–
	Family Paraphelenchidae			
56	*Paraphelenchus pseudoparietinus* (Micoletzky, 1922)	–	+	–
	Family Aphelenchoididae			
57	*Aphelenchoides composticola* Franklin, 1957	+	+	+
58	*Aphelenchoides* sp.	–	–	+
59	*Laimaphelenchus penardi* (Steiner, 1914)	–	–	+
	Order Tylenchida			
	Family Tylenchidae			
60	*Aglenchus agricola* (de Man, 1921)	+	+	–
61	*Coslenchus costatus* (de Man, 1921)	+	–	–
62	*Filenchus filiformis* (Butschli, 1873)	+	+	–
63	*Lelenchus cynodontus* Husain & Khan, 1967	+	+	–
64	*Tylenchus davainei* Bastian, 1865	+	+	–
65	*Tylenchus* sp.	–	+	+
	Family Neotylenchidae Thorne, 1941			
66	*Boleodorus thylactus* Thorne, 1941	+	–	–
67	*Nothotylenchus exiguous* Andrássy, 1958	+	–	–
	Family Paratylenchidae Thorne, 1949			
68	*Gracilacus audriellus* Brown, 1959	+	+	–
69	*Paratylenchus nanus* Cobb, 1923	+	+	–
	Family Anguinidae Nicoll, 1935			
70	*Ditylenchus dipsaci* (Kuhn, 1857)	+	–	–
71	*Ditylenchus* sp.	–	+	–
	Family Belonolaimidae Whitehead, 1959			
72	*Tylenchorhynchus dubius* (Bütschli, 1873)	+	–	–
	Family Pratylenchidae Thorne, 1949			
73	*Pratylenchus pratensis* (de Man, 1880)	+	–	–
	Family Hoplolaimidae Filipjev, 1934			
74	*Helicotylenchus dihystera* (Cobb, 1893)	+	–	–
	Family Heteroderidae Skarbilovich, 1947			
75	*Heterodera* sp.	+	–	–
Number of species		53	42	25

Our analysis revealed 75 species of nematodes belonging to ten orders: Dorylaimida (17 species), Tylenchida (16), Rhabditida (16), Plectida (9), Aphelenchida (5), Triplonchida (3), Monhysterida (3), Araeolaimida (2), Mononchida (2) and Enoplida (2). Representatives of all orders were found in the soil and the litter; however, species of Araeolaimida were absent in the moss.

Species of the orders Dorylaimida, Plectida, Rhabditida and Tylenchida comprised the core of the nematode communities in studied microhabitats in terms of species richness (fig. 1). They were represented by 45 species in the soil, 33 species in the litter and 15 species in epiphytic moss or 84.9 %, 78.6 % and 60.0 % of the species composition, respectively. Species richness of Tylenchida was higher in soil (14 species), Rhabditida — in litter (9 species), Dorylaimida and Plectida — in epiphytic moss (5 species of each order). Enoplida, Triplonchida, Araeolaimida, Mononchida, Monhysterida and Aphelenchida were represented by 1 to 3 species in all three microhabitats.

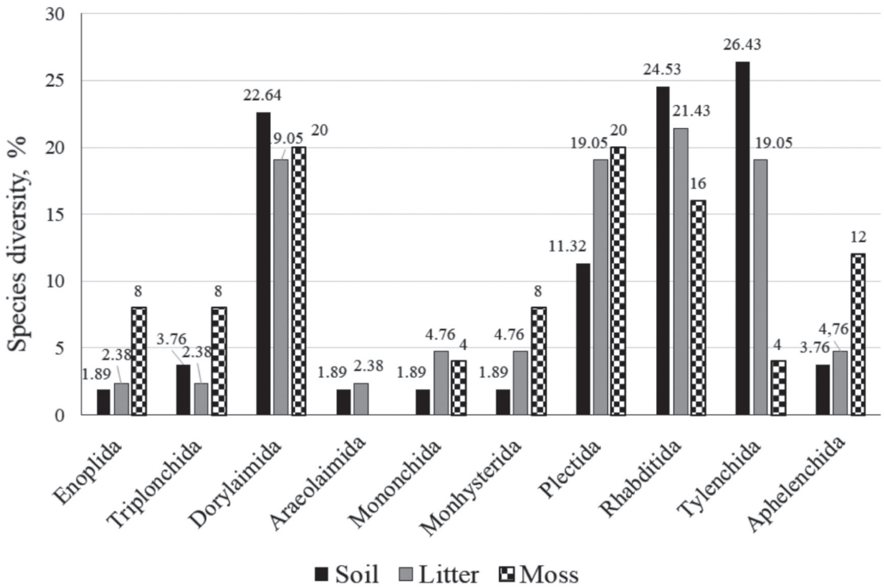

Fig. 1. Species diversity of nematodes belonging to different orders in the studied microhabitats of forest ecosystem.

Taxonomic composition of nematode communities was also documented by Poiras (2006) in different types of forest in Moldova. The highest number of species was noted for the orders Dorylaimida — 38 species (26.4 % of total number of species), Rhabditida — 32 (22.2 %), Tylenchida — 23 (15.9 %) and Plectida — 12 (8.3 %). Kozlovskyi (2009) also observed that Tylenchida, Rhabditida, Dorylaimida and Plectida formed the core of the species diversity of any forest ecosystem, while their number of species and dominance in the nematode assemblages might be different.

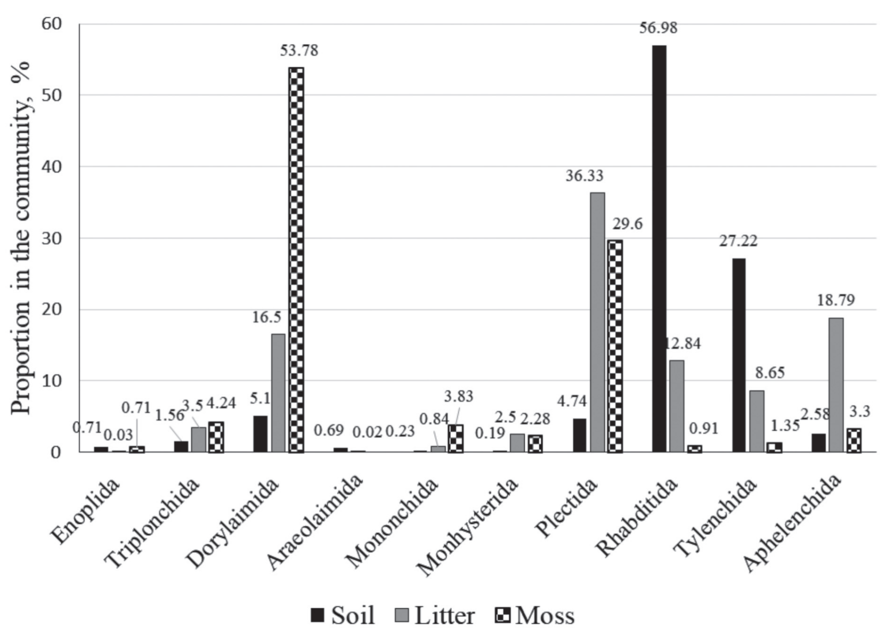

Fig. 2. Abundance of nematodes belonging to different orders in the studied microhabitats of forest ecosystem.

A proportional contribution (%) of various orders to the nematode communities in different habitats in forest ecosystem is shown in the figure 2.

Quantitative representation of four orders mentioned above (Dorylaimida, Plectida, Rhabditida and Tylenchida) combined together was 94.0 % in soil samples, 74.3 % in litter samples and 85.6 % in moss samples (fig. 2). The total abundance of the nematodes of other orders (Aphelenchida, Araeolaimida, Enoplida, Monhysterida, Mononchida and Triplonchida) together was higher in litter samples (25.7 %) than in soil and moss (6.0 % and 14.4 %, respectively).

Rhabditids were the most numerous in the soil (57 % from total abundance), tylenchids were the second numerous (27.2 %), dorylaimids and plectids were lower by the number of specimens in the community (about 5 % each).

The most abundant order was Dorylaimida (53.8 %), followed by Plectida (29.6 %) while Tylenchida and Rhabditida were insignificant (1.4 % and 0.9 %, respectively) in epiphytic moss.

The nematode fauna in the litter was different from the other microhabitats. Aphelenchida was among the orders that prevailed by the number of specimens in the community. In the litter, specimens of Plectida were the most numerous (36.3 %), followed by Aphelenchida (18.8 %), Dorylaimida (16.5 %) and Rhabditida (12.8 %). Tylenchids represented only 8.7 % of the nematode population in this microhabitat.

In Bulgaria, Lazarova et al. (2004) noted that Tylenchida and Dorylaimida were the dominant orders in the rhizosphere of *Quercus dalechampii* (mean relative abundance 35.0 % and 24.7 %, respectively), while the nematodes of the orders Areolaimida and Tylenchida dominated in the communities in the litter of *Q. dalechampii* (relative abundance 31.5 % and 24.4 %, respectively).

In total, 32 families of nematodes were identified in the studied microhabitats (table 2). Most of the species were from the families Plectidae (9 species), Qudsianematidae (8 species), Cephalobidae (7 species) and Tylenchidae (6 species). Number of the species in other families was 1–3. Most families, namely 15, were represented by one species, 9 families by two and four families by three.

The study of the diversity and spatial distribution of nematodes in the Store Mosse National Park (Sweden) revealed 47 families in total (Ahmed et al., 2023). The most represented families were Aphelenchoididae (7 genera), Rhabditidae (8 genera) and Tylenchidae (11 genera). Most of the families had more than one genus present.

We found that the number of families was higher in the soil (27 families) than in the litter and epiphytic moss (19 and 16 families, respectively).

In the studied samples, nematodes of 12 families (Aphelenchoididae, Aporcelaimidae, Cephalobidae, Dorylaimidae, Monhysteridae, Mononchidae, Panagrolaimidae, Plectidae, Prismatolaimidae, Qudsianematidae, Tylencholaimidae and Tylenchidae) were common to all microhabitats. On the other hand, species from some families were recorded exclusively in individual habitat. Aphelenchidae, Belonolaimidae, Diphtherophoridae, Heteroderidae, Hoplolaimidae, Longidoridae, Neotylenchidae, Osstellidae, Pratylenchidae, and Rhabditidae occurred only in the soil, Belondiridae and Paraphelenchidae in the litter, Teratocephalidae and Tripylidae in epiphytic moss.

In the soil, the most abundant families ($D > 10$ %) were Cephalobidae (27.67 %), Rhabditidae (26.05 %) and Tylenchidae (14.16 %); in the litter were Plectidae (36.33 %), Aphelenchoididae (17.79 %) and Dorylaimidae (13.91 %). Families Tylencholaimidae, Plectidae and Aporcelaimidae were more abundant in epiphytic moss (35.21 %, 29.6 %, 11.75 %, respectively).

Table 2. Parameters of the nematode communities dwelling in three microhabitats in the forest ecosystem from the MNNP

Characteristics	Microhabitat		
	Soil	Litter	Moss
Abundance ind./100g (mean value ± SD)	450.12 ± 283.10	3508.49 ± 3289.54	4621.55 ± 5309.51
Species	53	42	25
Genus	43	32	23
Family	27	19	16
Order	9	9	8
ST	132	102	72
H'	3.25	2.67	2.17
M	2.50	0.71	0.37

Note.ST — taxonomic wealth index; H' — Shannon-Wiener index of diversity, M — Menhinick's diversity index.

In total, 55 genera of nematodes were found in the studied microhabitats (table 2). The generic richness was higher in the soil (43 genera) than in the litter and epiphytic moss (32 and 23 genera, respectively). Our results are consistent with those reported by Yeates (2007) in forest ecosystems. Nematodes were identified to 39 and 62 genera from litter and soil, respectively. Lazarova et al. (2000) recorded 14 genera of nematodes from mosses on tree trunks in Bulgaria.

In the studied fauna, 11 genera were common to all microhabitats (table 1). The most abundant genera (D > 5 %) were *Plectus* (21.2 %), *Tylencholaimus* (12.1 %), *Aphelenchoides* (7.1 %), *Mesodorylaimus* (6.1 %). On the other hand, some genera were recorded exclusively in individual habitat. Sixteen genera occurred only in the soil, 3 genera *(Dorylaimellus*, *Paraphelenchus* and *Wilsonema)* in the litter and 4 genera *(Laimaphelenchus*, *Panagrobelus*, *Paratripyla* and *Teratocephalus*) in epiphytic moss (table 1).

Similar results on the nematode fauna were also observed in Chalkidiki (Greece) where nematode generic richness was the highest in the soil and the lowest in the upper-trunk mosses (Tsiafouli et al., 2017). On the other hand, Krivtsov et al. (2010) reported that taxonomic diversity appeared to be considerably greater in the litter horizon than in the soil; however, that might partly be due to the differences in the extraction procedures (in the soil, only 20 genera of nematodes were revealed, while 47 were revealed in leaf litter).

The species richness of the nematode fauna in the soil in our study was higher than in the litter and epiphytic moss. Soil-inhabiting nematodes were from 53 species, litter nematodes belonged to 42 species, whereas moss nematodes belonged to 25 species (table 2). We found that the number of nematode species per sample was highly variable within the three habitats. The number of species per soil sample ranged from 9 to 22 (15.5 ± 4.5), in litter samples it ranged from 4 to 20 (11.1 ± 4.1) and in moss samples it ranged from 2 to 16 (6.4 ± 4.3).

Our results are consistent with those reported by Lazarova et al. (2004), who studied the structure of nematode communities in different microhabitats within a relatively small area of a natural oak forest in Bulgaria. Generic richness of the nematode fauna in the soil was higher than in the litter and moss on tree trunks (23, 13 and 5 genera, respectively). In Slovak and Czech Republic, Renčo et al. (2012) distinguished 87–167 species in the forest soils. Ciobanu and Popovici (2017) found 42–109 species in forest habitats from Romania. In Moldova, Poiras (2006) indicated that the richness of soil nematode species varied from high value in beech forests (65) to low value in maple-hornbeam and oak forests (34–38).

Twenty species from 14 genera were recorded in the mosses on tree trunks in Bulgarian natural oak forest (Lazarova et al., 2000). The nematode fauna of epiphytic mosses in green plantations of Chernihiv included 40 nematode species belonging to 30 genera (Shevchenko & Zhylina, 2016).

The taxonomic wealth index (ST), and diversity (based on M and H' indices) of nematode communities in the soil were significantly higher than those in the litter and moss (table 2). ST in the soil was 132, compared to 102 in the litter and 72 in epiphytic moss. M ranged from 2.50 in the soil to 0.37 in the moss. The lowest value of Shannon-Wiener index of diversity was recorded in the moss (2.17), while the highest was in the soil (3.25). In the natural oak forest in Bulgaria, the nematode communities of soil microhabitat were characterized by the highest diversity (H' = 2.42–2.59). Nematode communities of litter microhabitat occupied an intermediate position (H' = 1.78–1.86), followed by the nematode communities in mosses which showed the lowest diversity (H' = 0.86–1.14) (Lazarova et al., 2004).

A trend towards higher nematode taxa richness in forested soil microhabitat may suggest more abundant and heterogenous resources in relation to the litter and epiphytic moss.

The nematode communities inhabiting the soil had similar taxonomic composition to litter nematode communities (J = 0.40) and showed lower level of similarity compared to the communities of epiphytic moss (0.18). Nematode communities of mosses were similar to those inhabiting the litter (0.31).

Scientists traditionally use microclimatic information to explain the taxonomic composition and community diversity, distribution of organisms in natural ecosystems (Perry, 1994; Xu et al., 1997). Forest soil microhabitat is subjected to relatively small fluctuations in microclimatic conditions (Grimmond et al., 2000; Von Arx et al., 2012; Frenne et al., 2021). On the other hand, epiphytic mosses are strongly affected by moisture and temperature regimes which affect the animals that use epiphytes for habitat (Bohlman et al., 1995; Proctor, 1982; Rambo & North, 2008).

In our study soil microhabitat had the most diverse nematode communities. In contrast, the epiphytic moss had nematode communities with lower diversity. We confirmed the results previously obtained by Lazareva (2004) about spatial patterns of variation in the composition and structure of nematode communities in relation to different microhabitats.

We found that nematode communities were more diverse in the soil. On the other hand, the nematode abundance was higher in epiphytic moss. The highest abundance (mean value 4621.55 ind./100 g) was recorded in the epiphytic moss, followed by that in the litter (3508.49 ind./100 g). The lowest nematode abundance (450.12 ind./100 g) was found in the forest soil (table 2). Imilarly, Krivtsov et al. (2010) reported that nematode abundance appeared to be considerably greater in the litter horizon than in the soil from Heron Wood (Scotland).

The dominance of species in the three studied microhabitats had its own characteristics (fig. 3).

Only ten species, *A. granulosus*, *A. composticola, E. oxyuroides*, *M. bastiani*, *P. intermedius*, *P. cirratus*, *P. parietinus*, *P. parvus*, *P. rigidus* and *T. teres* were common for all three studied microhabitats. Of these, four were eudominant species, namely *A. composticola*, *M. bastiani*, *P. cirratus* and *T. teres. P. cirratus* developed was abundant both in litter (15.8 %) and in epiphytic moss (20.1 %). *M. bastiani* and *A. composticola* were predominant in the litter (13.91 % and 17.79 %, respectively), while *T. teres* was mostly in epiphytic moss (35.21 %).

Seventeen species were common only in the soil and litter, 6 species were in the litter and mosses (*G. villosa*, *E. vulgaris*, *P. muscorum*, *R. terrestris*, *Tylenchus* sp., *T. auriculatus*), 2 species were common in the soil and mosses (*A. primitivus* and *E. monohystera*).

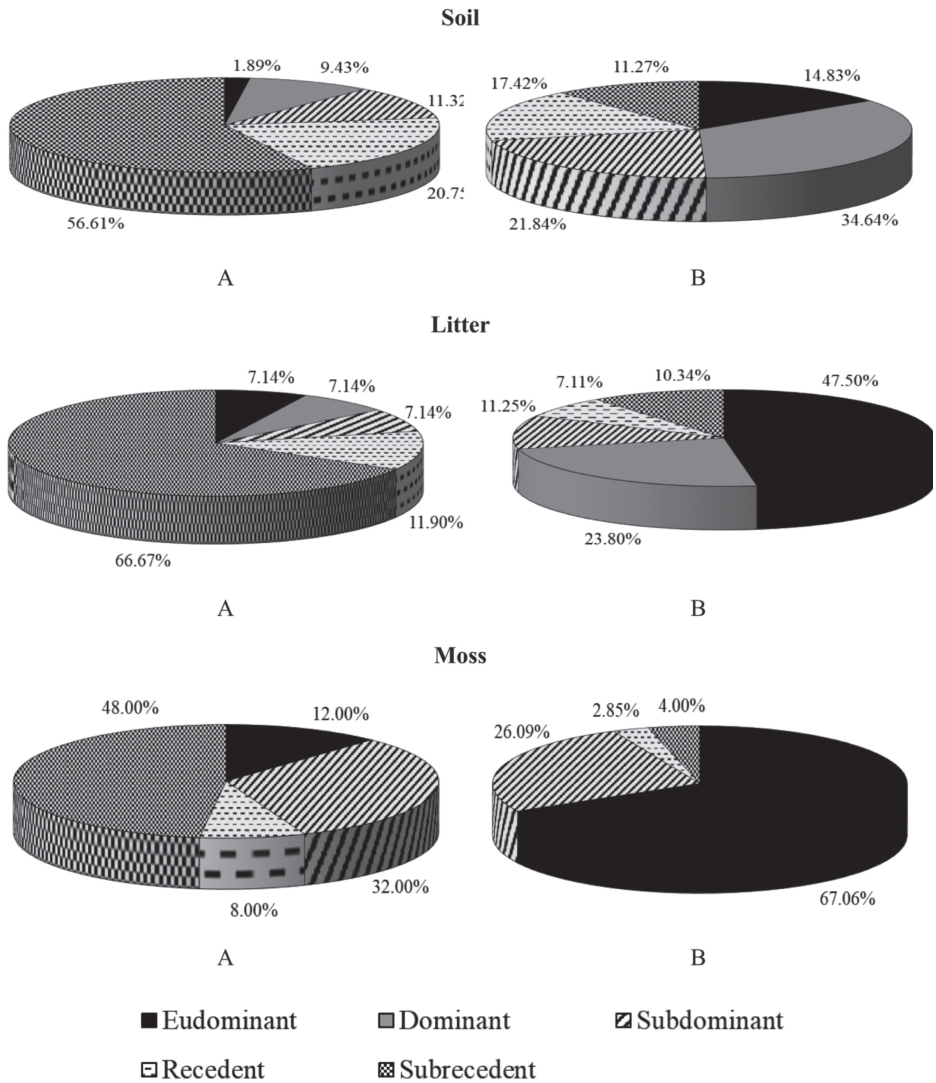

Fig. 3. Structure of nematode fauna of the studied microhabitats of forest ecosystem according to the dominance criterion: A — species diversity, %; B — abundance, %.

The greatest species diversity was noted for the subrecedents and recedents. Subrecedents and recedents were represented in the soil by 30 and 11 species or 56.61 % and 20.75 % of the species composition, respectively, and in the litter by 28 and 5 species or 66.67 % and 11.90 % of the species composition, respectively. Subrecedents were the greatest group by the number species in the moss (12 species or 48 % of the species composition); the following group were subdominants (8 species or 32 % of the species composition) (fig. 3, A).

Thus, the species richness of nematode communities in each of the studied microhabitat was formed mostly by subrecedents. On the other hand, the proportion in the community of subrecedents was over 11.27 % in the soil, 10.34 % in the litter and 4 % in epiphytic moss (fig. 3, B).

One species was recorded in the eudominant group, namely *R. filiformis* (proportion in the community 14.83 %) in the forest soil. Dominants were the most abundant (34.64 %). They were *A. agricola, A. bűtschlii*, *C. persegnis*, *N. exiguous* and *R. brevispina*.

Eudominants were the most numerous in the litter and epiphytic moss samples (47.50 % and 67.06 % of all specimens collected, respectively). They were *A. composticola*, *M. bastiani*, *P. cirratus* in the litter and *A. paracentrocercus*, *P. cirratus, T. teres* in the moss. Four species: *P. parietinus, P. parvus*, *P. rigidus, Tylenchus* sp. were dominant group in the litter (23.8 % together). This group was absent in epiphytic moss. Thus, the structure of the nematode communities inhabiting the litter and moss microhabitats was characterized by a high 'concentration of dominance' of three species, whereas the rest of the species were of low abundance. This corresponds with the results of Lazarova et al. (2000) where two taxa (*Plectus* spp. and *G. villosa*) occurred in almost all samples and were the most numerous species in moss samples from tree.

Conclusion

The results of the present study indicated that taxonomic composition and nematode community diversity in the natural mesophilic broad-leaved forest differed significantly between three microhabitats: the soil, the litter and epiphytic mosses. In general, the soil exhibit greater nematode taxonomic diversity than the litter and epiphytic mosses. It was shown that each studied microhabitat is characterized by a special composition of families and genera of nematodes.

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