# SPECIFIC AND TROPHIC DIVERSITY OF SOIL NEMATODES IN FOREST ECOSYSTEMS FROM THE ZARAND MOUNTAINS

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The nematode fauna of several deciduous forests from the Zarand Mountains has been studied. The nematode communities are dominated by 12 genera: *Filenchus, Aphelenchoides, Plectus, Criconemella, Aporcelaimellus, Tylencholaimus, Ditylenchus, Eudorylaimus, Tylocephalus, Tripyla, Gracilacus,* and *Takamangai.*

Fifteen nematode species are new records for the Romanian fauna. Two distinct clusters of nematode communities, based on specific affinity, are noted. The major part of nematode populations are located in the humiferous soil horizon. Preferences either for organic or mineral horizons are noted for some species. The trophic structure is dominated by plant-feeding nematodes followed by bacterial-feeding and hyphal-feeding ones.

Nematodes rank among soil fauna groups which are highly diversified and have pronounced densities; they are present at different trophic levels of the soil food web (Yeates et al., 1993) and are distributed in about all kinds of terrestrial habitats (Petersen and Luxton, 1982; Wasilewska, 1979; Yeates, 1989).

Our knowledge on the European nematode fauna of deciduous forests included studies from Denmark (Yeates, 1972; 1973), The Netherlands (Bongers et al., 1989; De Goede, 1993; De Goede and Bongers, 1994), Germany (Büttner, 1989) and Romania (Popovici, 1984; 1989; 1993).

The southwestern part of the Apuseni Mountains (part of the Romanian Carpathians), represented by the Zarand Mountains, is dominated by deciduous forests and has so far remained unexplored with regard to the nematode fauna and its distribution.

The results of the investigations carried out in 1993, in some representative forests of this area, are presented in this study.

## MATERIALS AND METHODS

The study was undertaken in ten sites of the Zarand Mountains represented by three ecosystem types: beech forest (As. *Symphyto-Fagetum* Vida, 63), hornbeam-beech forest (As. *Carpino-Fagetum* Paucă, 1941), and durmast oak forest (As. *Quercetum petraeae-cerris* Soó, 57).

The soils of these stations varied from brown earth to podzolic brown. The forest and soil types as well as their location were as follows:

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1. Mădrigești (a), beech forest, 350 m altitude, acid brown soil;
2. Mădrigești (b), hornbeam-beech forest, 400 m altitude, acid brown soil;
3. Leurza Valley, hornbeam-beech forest, 400 m altitude, acid brown soil;
4. Brocca, hornbeam-beech forest, 280 m altitude, acid brown soil;
5. Cladova (a), hornbeam-beech forest, 300 m altitude, brown earth soil;
6. Cladova (b), hornbeam-beech forest, 250 m altitude, brown earth soil;
7. Milova, hornbeam-beech forest, 380 m altitude, brown earth soil;
8. Bârzava (a), durmast oak forest, 400 m altitude, yellowish podzolic brown soil;
9. Bârzava (b), durmast oak forest, 400 m altitude, podzolic brown soil;
10. Corbești, durmast oak forest, 280 m altitude, brown earth soil.

The sites were sampled in May 1993. Five samples, consisting of five cores each (26 mm diameter, 15 cm high), were taken both from litter and 0–15 cm of the mineral soil, except the site no. 9, sampled only down to 10 cm of the soil; the cores of each sample were bulked and sub-samples were taken for nematode extraction and soil humidity.

Nematodes were extracted by using centrifugation method with $MgSO_4$ solution (d=1.18) and were fixed with 4% formaldehyde solution. Soil humidity was determined after drying for 24 h at 105°C.

The nematodes were identified and their trophic structures were allocated to bacterial feeding, hyphal feeding, plant feeding, omnivores and predators following Yeates et al. (1993).

## RESULTS AND DISCUSSION

The nematode fauna of deciduous forests in the Zarand Mountains comprises 90 genera with 110 species identified so far (Table 1).

The highest specific diversity (86 taxa) was recorded in brown earth soil of the hornbeam-beech forest at Cladova (a), while the lowest one (46 taxa) was identified in podzolic brown soil of the durmast oak forest from Bârzava (b).

The major part of the species is cosmopolitan, commonly found in other forest ecosystems from Romania and other European countries, too (Wasilewska, 1979; Popovici, 1984; 1989; 1993; Bongers et al., 1989; De Goede, 1993).

Fifteen species, published here, are new records for the Romanian fauna. In Table 1 they are marked with an asterisk. Some of these are rare species for the European fauna, namely: *Anatonchus hortensis, Boleodorus thylactus, Clavicauda longicaudata, Hexatylus viviparus, Leptolaimus papilliger, Opisthodorylaimus sylphoides, Plectus decens* and *Pungentus pungens.*

The nematode fauna is dominated by the genera *Filenchus, Aphelenchoides, Plectus* and *Criconemella.* Genera *Aporcelaimellus, Eudorylaimus, Ditylenchus, Gracilacus, Tripyla, Takamangai, Tylecholaimus* and *Tylocephalus* are dominant only in one or two of the studied stations (Table 2).

*Table 1*

Specific structure of nematode communities in forest ecosystems from the Zarand Mountains

| Taxon | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ord. Tylenchida | | | | | | | | | | |
| Basiria duplexa* | | | | | | ■ | | ■ | | |
| Boleodorus thylactus* | | | | | | | | ■ | | |
| Coslenchus costatus | | | ■ | | | | ■ | ■ | ◆ | ■ |
| Filenchus sp. | □ | □ | □ | □ | □ | □ | □ | ■ | □ | ■ |
| F. polyhypnus | □ | □ | □ | □ | □ | ■ | □ | ■ | ■ | ■ |
| F. vulgaris | ◆ | | | ■ | ■ | □ | | ■ | | ■ |
| Lelenchus leptosoma | | | ■ | ■ | ■ | | □ | ■ | | |
| Tylenchus davainei | | ■ | ◆ | ■ | ◆ | ■ | ◆ | ■ | □ | □ |
| Malenchus bryophilus | □ | ■ | | ■ | ■ | | | | | |
| Cephalenchus hexalineatus* | | | | | | ■ | | | | |
| Trophurus sculptus | ■ | | | | | | | | | |
| Ditylenchus sp. | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| D. intermedius | ◆ | □ | ■ | | | ■ | ◆ | ◆ | □ | ■ |
| Ecphyadophora tenuissima | | ■ | | ■ | ◆ | ■ | | | | |
| Tylenchorhynchus sp. | | | | ■ | | | | | | |
| Pratylenchus sp. | ■ | | ■ | | ■ | | ■ | | | |
| Hexatylus viviparus* | | | | | □ | □ | | | | |
| Paratylenchus sp. | | | | ■ | □ | ■ | | | | |
| Gracilacus sp. | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ |
| Helicotylenchus sp. | | | | | | ■ | | | | ■ |
| Rotylenchus robustus | □ | □ | | | | | | | | |
| Rotylenchulus borealis* | | ■ | | | | | | ■ | | |
| Criconemella macrodora | □ | □ | ■ | ■ | ■ | □ | ■ | ■ | □ | □ |
| C. rustica | | | | | | | | | ■ | |
| Criconema sp. | | | | | | | | | | ■ |
| C. annuliferum | | | | ■ | | | | | | |
| C. princeps | | | | | | | | ■ | | ■ |
| Ogma menzeli | ■ | ■ | | ■ | ■ | | | | | |
| Meloidogyne sp. (juveniles) | | | | | ■ | | | | | |
| Aphelenchus avenae | | | | | ■ | | | ■ | | |
| Paraphelenchus pseudoparietinus* | □ | ◆ | □ | ◆ | | | ◆ | | ■ | |
| Aphelenchoides sp. | □ | □ | ■ | □ | □ | □ | □ | □ | □ | □ |
| Deladenus durus | | □ | ■ | □ | ◆ | ◆ | | | | ◆ |
| Ord. Rhabditida | | | | | | | | | | |
| Rhabditidae (dauer-larvae) | ◆ | ■ | ■ | ◆ | ■ | □ | | ■ | ◆ | □ |
| Rhabditis terricola | ■ | □ | □ | | ■ | ■ | | □ | | ■ |
| Protorhabditis oxyuroides* | | | ■ | ■ | □ | □ | | ■ | | ■ |
| Mesorhabditis spiculigera | | | | ■ | ◆ | □ | | | ■ | □ |
| Pristionchus lheritieri* | ■ | ◆ | | | ◆ | ◆ | ◆ | □ | ◆ | □ |
| Bunonema reticulatum | □ | | □ | □ | □ | | □ | | □ | □ |
| B. richtersi | | | | ■ | ◆ | | | | | |
| Cephalobus sp. | | □ | ◆ | | ■ | ■ | | ■ | | |
| Eucephalobus oxyuroides | ■ | □ | ◆ | ■ | □ | ■ | ◆ | □ | | ■ |
| E. striatus | | | | | | | | | ■ | □ |
| Heterocephalobus elongatus | □ | □ | □ | ◆ | ◆ | □ | ◆ | □ | ■ | □ |
| Chiloplacus sp. | | | | | ■ | | ◆ | ◆ | ■ | |
| Acrobeles ciliatus | | | | | | | | ◆ | | |
| Acrobeloides nanus | □ | □ | ■ | □ | □ | □ | ■ | □ | ■ | |

*Table 1* (continued)

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* First time recorded for the Romanian fauna.
◆ Found only in litter.
■ Found only in mineral soil.
□ Found in both horizons.

Genera *Aphelenchoides, Plectus, Ditylenchus* and *Tylocephalus* developed abundant populations in litter. The genus *Filenchus* had a major contribution (5.4 – 37.5%) to the entire nematode communities, followed by *Criconemella* (5.8–12% ) and *Gracilacus* (6%) (Table 2).

The cluster analysis of the nematode communities, based on specific affinity (when 55% similarity level is used), revealed two distinct clusters (Fig. 1) separated at 63% of similarity: one cluster was formed by the nematode communities of beech and hornbeam-beech forests developed on acid brown and brown earth

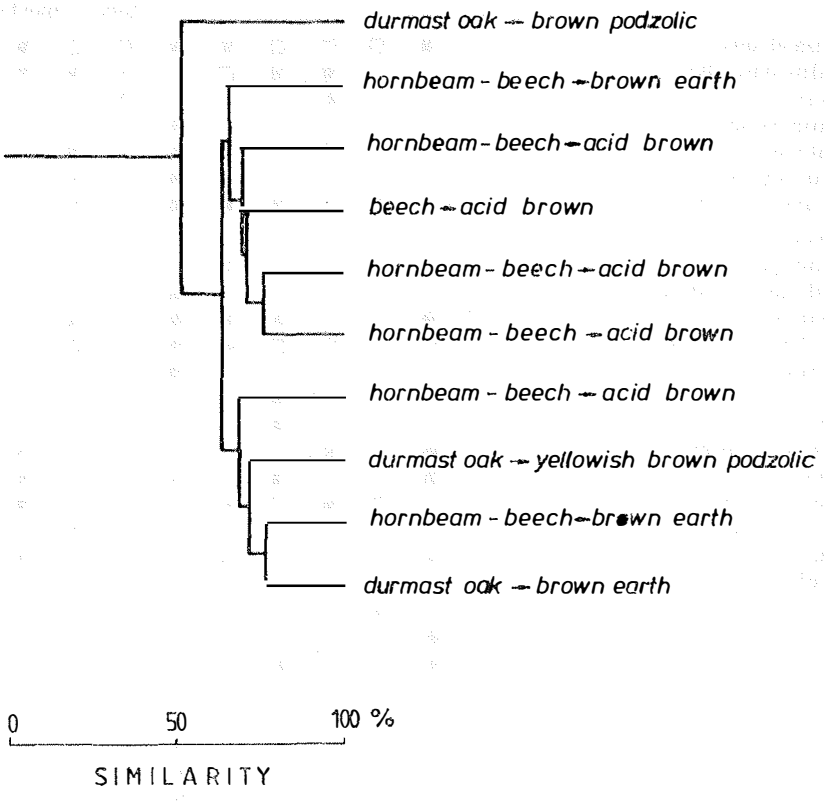


Fig. 1. – Dendrogram of cluster analysis for nematode communities, based on specific affinity, in the deciduous forests from the Zarand Mountains.

*Table 2*

The dominant genera (%) of nematode communities in forest ecosystems from the Zarand Mountains

| Genera | Forest ecosystems (site number) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Beech (1–3) | | | Hornbeam-beech (4–7) | | | | Durmast-oak (8–10) | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Aphelenchoides | 9 | 5 | 12 | 5 | 7 | 38 | 10 | 12 | 6 | 21 |
| Filenchus | 20 | 17 | 12 | 37 | 24 | 16 | 20 | 11 | 34 | 5.5 |
| Plectus | 11 | 12 | 14 | 8 | 10 | 9 | 8 | 8 | 13 | 30 |
| Criconemella | 12 | 10 | 6 | | 7 | | 7 | | | |
| Aporcelaimellus | | | 6 | | | | | 7 | | |
| Ditylenchus | | | | 6 | | | 7 | | | |
| Takamangai | | 5.5 | | | | | | | | |
| Eudorylaimus | | | 6.5 | | | | | | | |
| Tripyla | | | | | | | 6 | | | |
| Gracilacus | | | | | | | | 6 | | |
| Tylencholaimus | | | | | | | | | 9.5 | |
| Tylocephalus | | | | | | | | | | 6.5 |

soils; another cluster was represented by the communities of hornbeam-beech and durmast oak forests evolved either on acid brown/brown earth or on yellowish brown podzolic soil. The nematode community of the durmast oak forest on brown podzolic soil was separated from all other communities at 55% of similarity. It had the lowest specific diversity, most of the taxa being commonly found in forest ecosystems.

The abundance of nematode communities ranged between 1.6 and 5.6 mil.m$^{-2}$ in mineral soil (Table 3); the highest value of nematode abundance in litter was noted in the hornbeam-beech forest at Leurza Valley. The nematode populations were mostly located in the mineral soil horizons (73–99% of the whole estimated communities). Generally, the abundance of nematode communities, between 2.2 and 5.6 mil.m$^{-2}$, was closed to the data given by other authors for forest ecosystems (Petersen and Luxton, 1982; Wasilewska, 1979; Yeates, 1989).

*Table 3*

Mean abundance (mil. m$^{-2}$) of nematode communities in forest ecosystems from the Zarand Mountains

| No. of site | Ecosystem | Litter | Mineral soil | Total |
|---|---|---|---|---|
| 1 | Beech | 0.87 | 2.39 | 3.26 |
| 2 | Hornbeam-beech | 0.61 | 3.61 | 4.22 |
| 3 | Hornbeam-beech | 1.17 | 3.29 | 4.46 |
| 4 | Hornbeam-beech | 0.28 | 4.17 | 4.46 |
| 5 | Hornbeam-beech | 0.28 | 2.32 | 2.60 |
| 6 | Hornbeam-beech | 0.68 | 2.25 | 2.93 |
| 7 | Hornbeam-beech | 0.45 | 3.07 | 3.52 |
| 8 | Durmast-oak | 0.58 | 1.62 | 2.20 |
| 9 | Durmast-oak | 0.01 | 5.60 | 5.61 |
| 10 | Durmast-oak | 0.24 | 2.49 | 2.73 |

The distribution of the trophic groups through the studied soil profile and on different horizons is illustrated in Fig. 2–6.

Plant-feeding nematodes prevailed over all other groups of nematodes in mineral horizon, in all studied stations. This feeding group was also dominant when the whole profile was taken into account, except the communities of the hornbeam-beech (Fig. 4) and durmast oak forests (Fig. 5), where hyphal- and, respectively, bacterial-feeding nematodes had the highest contribution.

Bacterial-feeding nematodes were mostly abundant in the mineral soil layer (Fig. 2–4; 6), except the durmast oak forest at Corbeşti (Fig. 5), where they prevailed in litter over all the other groups. The genus *Plectus* had a relatively high abundance in all stations, being mainly common in litter.

Hyphal-feeding nematodes outnumbered all other trophic groups only in brown earth soil of the hornbeam-beech forest from Cladova (b) (Fig. 6). The genus *Aphelenchoides* had a constant high contribution to the nematode communities in all stations, being mainly found in litter, while the genus *Tylencholaimus* was abundant only in the mineral soil of the durmast oak forest from Bârzava (2) (Table 2).

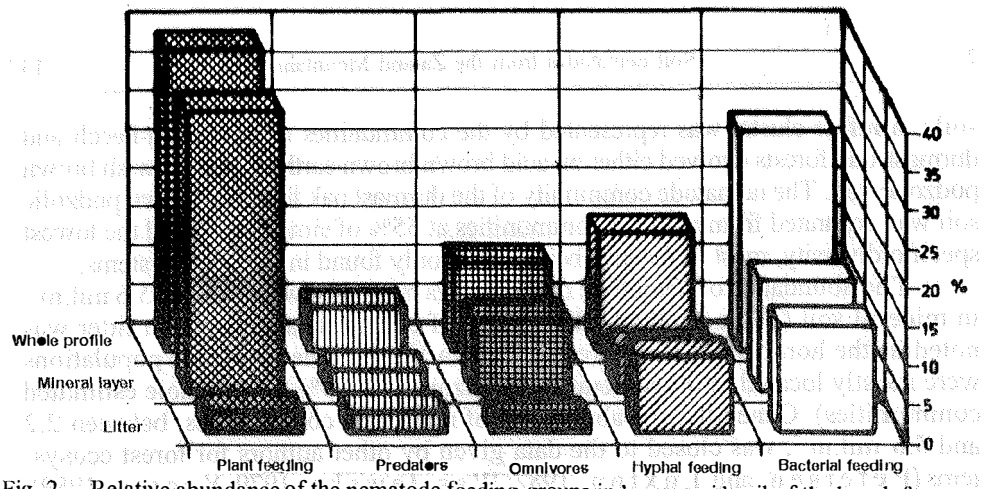


Fig. 2. – Relative abundance of the nematode feeding groups in brown acid soil of the beech forest from Mădrigeşti (a).

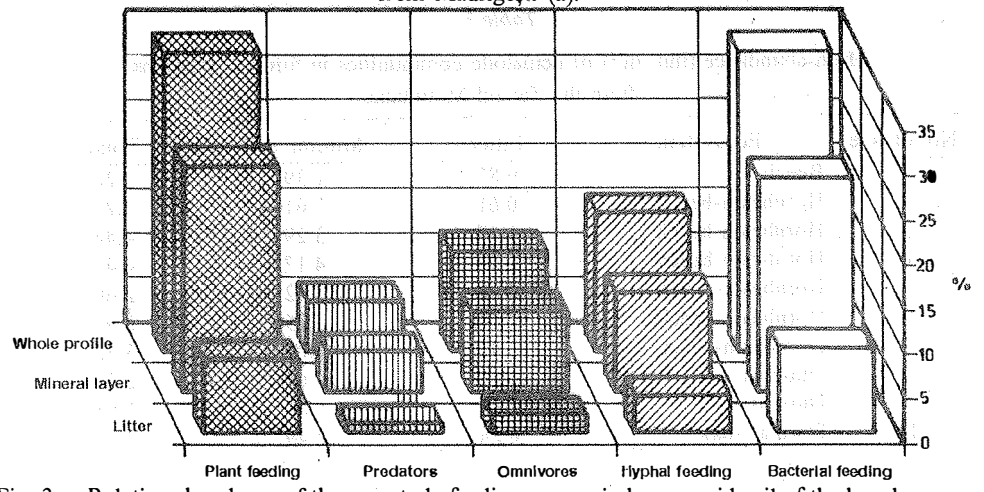


Fig. 3. – Relative abundance of the nematode feeding groups in brown acid soil of the hornbeam-beech forest from Mădrigeşti (b).

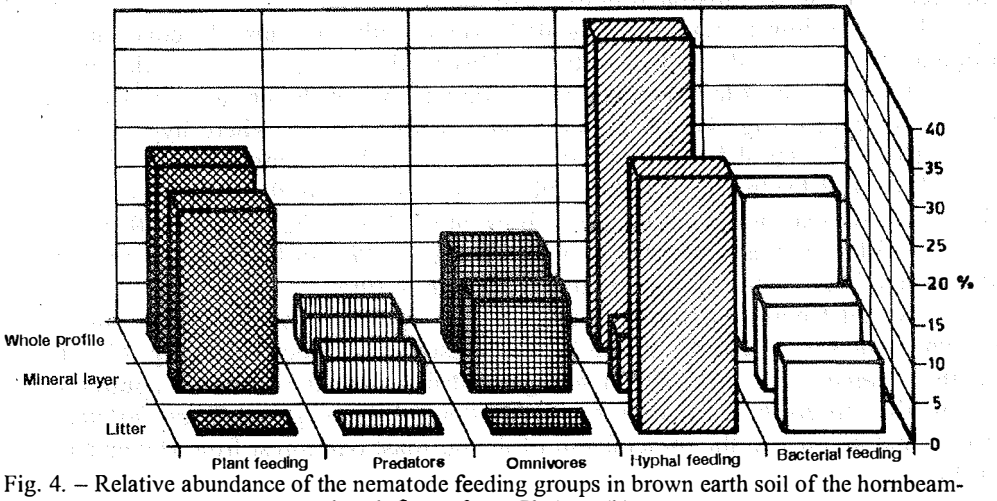


Fig. 4. – Relative abundance of the nematode feeding groups in brown earth soil of the hornbeam-beech forest from Cladova (b).

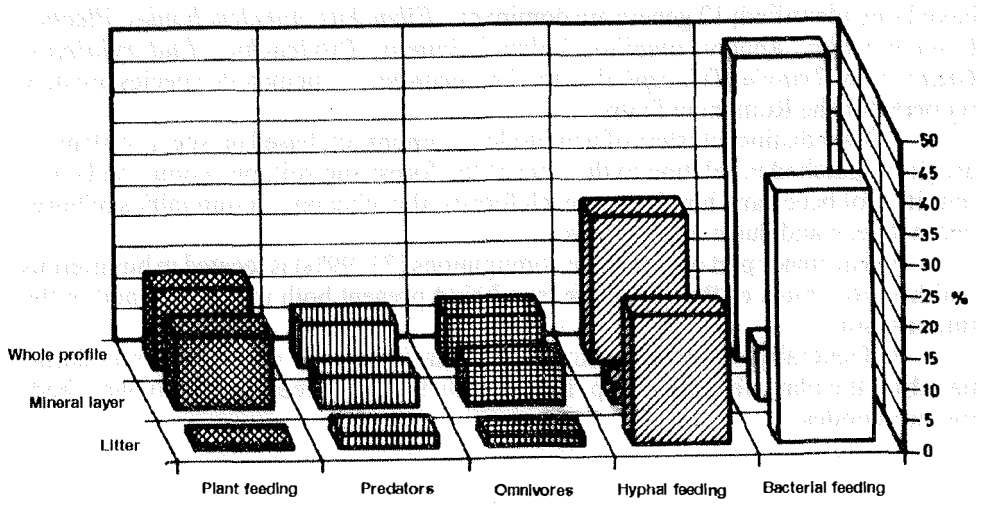


Fig. 5. – Relative abundance of the nematode feeding groups in brown earth soil of the durmast oak forest from Corbeşti.

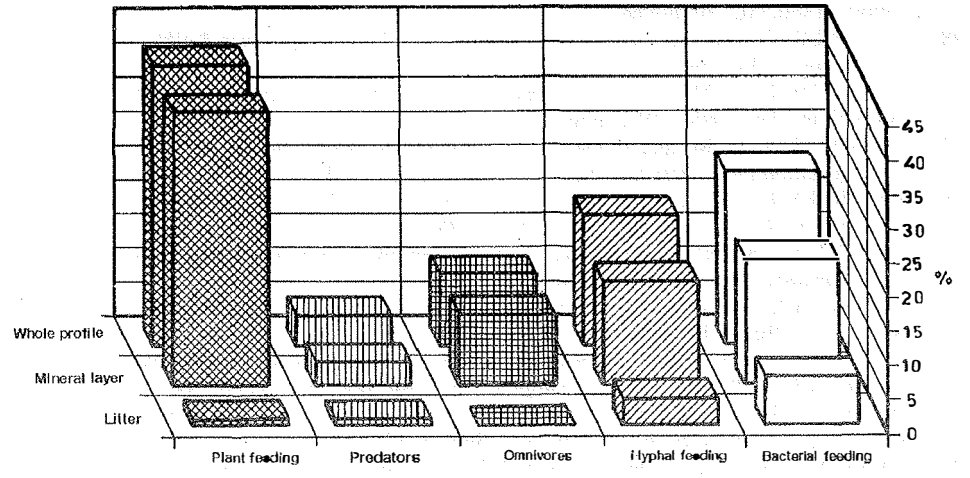


Fig. 6. – Relative abundance of the nematode feeding groups in podzolic brown soil of the durmast oak forest from Bârzava (b).

Omnivores and predators had low contributions (Fig. 2–6) to the nematode communities.

## CONCLUSIONS

1. The nematode fauna of several deciduous forests in the Zarand Mountains (western Carpathians) has a pronounced specific diversity: 90 genera, 110 species

have been identified; 12 genera are dominant – *Filenchus, Aphelenchoides, Plectus, Criconemella, Aporcelaimellus, Tylencholaimus, Ditylenchus, Eudorylaimus, Gracilacus, Tripyla, Tylocephalus* and *Takamangai*; 15 nematode species are new records for the Romanian fauna.

2. Two distinct clusters of nematode communities, based on specific affinity, are distinguished in relation to the type of the forest and soil: one comprised communities of beech and hornbeam-beech forests, the other one, communities of hornbeam-beech and durmast oak forests.

3. The major part of nematode communities (73–99%) is located in humiferous soil horizon, most of the nematode taxa being present both in the litter and in the mineral soil.

4. Generally, the trophic structure of the nematode communities is dominated by the plant-feeding group, followed by bacterial-feeding and hyphal-feeding nematodes.

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