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NEMATODES (NEMATODA) IN POLISH FORESTS. I. SPECIES INHABITING SOILS OF NURSERIES

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Abstract: The paper presents the results of the analysis of 472 soil samples collected in the 1986–1987 time period, from 209 forest nurseries located in different regions of Poland. In total, 119 species of nematodes belonging to 56 genera were found: 64 species considered as plant feeders – parasites of higher plants, 34 species classified as fungal, epidermal cell and plant root hair feeders, 12 species of predatory nematodes, 2 species of omnivorous and 6 species of bacterial feeders.

The most frequent species was *Aphelenchus avenae* which occurred in 45% of samples, followed by *Paratylenchus projectus* 22%, *A. saprophilus* 21%, *A. bicaudatus* 20%, *P. pachydermus* 20%, *Trichodorus sparsus* 20%, *Aphelenchoides composticola* 18%, *A. parietinus* 18%, *Pratylenchus crenatus* 17%, *Bitylenchus dubius* 14%, and *P. penetrans* 11%.

Several species were very abundant *e.g.* maximal population density (number of specimens in 200 cm^3 of soil) of *Cephalenchus hexalineatus* was 3,180 individuals, of *A. saprophilus* 2,500 individuals, of *Filenchus nemorosus* 2,450 specimens, of *Ditylenchus anchilisposomus* 850 individuals, of *Meloidogyne hapla* 800 individuals, of *Coslenchus costatus* 560 individuals, of *B. dubius* 410 specimens, and of *Rotylenchus robustus* 400 specimens.

Nematode communities very poor in omnivorous and predatory species indicated that soil quality in the forest nurseries was very low. Such a finding means that seedlings could be less resistant to parasites and pathogens.

The obtained results indicated that *P. penetrans*, *R. robustus* and species belonging to the family Trichodoridae could inhibit the growth of seedlings in nurseries.

Key words: nematodes, fungi, soil, *Aphelenchus avenae*

INTRODUCTION

Nematodes associated with forest nurseries in Europe were surveyed by numerous authors *e.g.* Nolte 1957; Nolte and Dieter 1957; Decker 1960; Bassus 1969; Boag 1978; Loyttyniemi and Sarakoski 1978; Sohlenius 1996; Gubina 1980; Stollarova 1999. In Poland, nematodes inhabiting soil in forest nurseries have been studied by Wasilewska (1969), Wolny (1973, 1980) and Dobies (2004).

The harmfulness of nematodes to forest seedlings and to young trees was indicated by Decker (1960), Colbran (1964), Goodey (1965), Sutherland (1967), Bassus (1969), Hijink (1969), Fortuner (1982), Magnusson (1983), Hanel (1996), Okada *et al*. (2002), Tomalak (unpublished information). Plant parasitic nematodes feeding on roots can seriously damage young seedlings and as a result inhibit the growth of trees. Moreover, plant parasitic nematodes enable penetration of soil inhabiting fungi and bacteria into the cortical tissue of seedlings. Some of these bacteria and fungi could be plant pathogens. Plant feeding nematodes in combination with pathogenic fungi or bacteria cause a "complex disease" which often results in a loss that is more than additive (Powell 1971). Some species of nematode belonging to the genera: *Longidorus*, *Trichodorus*, *Xiphinema* are vectors for important plant viruses (Taylor and Brown 1997).

The threshold of plant tolerance for parasites depends among others, on the condition of the plant. Plant tolerance is affected by the soil environment; the better the quality of the soil system the higher the resistance of plants to parasites and pathogens. Soil quality depends on the food web structure which is largely constructed by nematodes belonging to different trophic groups: bacterial, fungal, algae, lichens, higher plant feeders, omnivores and predators involved to the soil processes, such as: matter circulation and energy flow, organic matter decomposition, turnover of microbial communities and thus, in the flux of plant nutrients (Wasilewska 1971a; Sohlenius 1979; Anderson *et al*. 1981; Popovici 1984; Ingham *et al*. 1985; Coleman *et al*. 1990; Ettema and Bongers 1993; Bloem *et al*. 1994; Bouwman *et al*. 1994). Especially the presence of omnivorous and predators in a soil is very desirable because representatives of these two groups of nematodes enrich the soil food web in various trophic

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links. It provides stability of soil system and its resistance to disturbance.

Furthermore, predatory nematodes may play a role in the biological control of plant feeding species. Thorne (1927), first noted the role that predatory nematodes play in decreasing populations of plant parasitic nematodes. He observed *Mononchus papillatus* (now classified as *Clarcus papillatus*) consume 1,332 juvenilles of *Heterodera schachtii* – the parasite of sugar beet. Szczygieł (1971a) also observed *Clarcus papillatus* and *Anatonchus tridentatus* feeding on *Meloidogyne* larvae.

The role of different trophic groups of nematodes and the relationships between them were mentioned above. With this information in mind, it seems important to analyze a whole nematode community in an environment, instead of an analysis of a selected group *e.g.* plant feeders.

This paper reports the results of a faunistic survey of nematodes belonging to different trophic groups inhabiting soil of different forest nurseries in all regions of Poland.

The soil environment in forest nurseries which was intensively irrigated as well as treated with fertilizers and plant protection products becomes an environment subjected to anthropogenic pressure. In some aspects, such nursery soil could be more similar to the soil of a cultivated field than to forest soil. Therefore, one might expect that nematode communities inhabiting forest nurseries are more similar to the nematode communities inhabiting cultivated fields than to those occurring in forest soil.

MATERIALS AND METHODS

The investigation was carried out in all regions of Poland. The location of 209 forest nurseries is presented on figure 1.

During a two year period (1986–1987) 472 soil samples (usually 2–3 samples in each nursery) were collected. The samples, each about 1,000 cm[3] were taken to a depth of 25–30 cm from the vicinity of the tree roots. After a careful mixing of the soil, nematodes were extracted from two subsamples, each 100 cm[3]. Larger species of nematodes were extracted from a subsample by flotation-incubation methods (Flegg 1967), while smaller species were extracted from the second subsample by centrifugation (Szczygieł 1971). Nematodes obtained in two ways were mixed, then killed by adding hot formaline 5%, and preserved in formaline 3%. Permanent slides in glycerin were made by the Seinhorst rapid method (1959). Sample representatives were examined by the Beklemishev

Fig. 1. UTM (Universal Transverse Mercator) grid map of Poland. Black dots show the localities of the surveyed forest nurseries

method (Kozłowska and Wasilewska 1981). Systematic classification of nematodes, identified to species level, was based on the filogenetic system accepted in Fauna Europea (Winiszewska 2008). Identified nematodes were divided into the following trophic groups, according to the classification proposed by Yeates *et al.* (1993): Plant feeders (A1 – migratory endoparasites, A2 – semiendoparasites, A3 – ectoparasites, A4 – sedentary parasites), B – bacterial feeders, C – predators, D – omnivorous nematodes, F – epidermal cell feeders, plant root hair feeders and fungal feeders. For every species the following parameters were calculated:

i) population density (number of individuals in 200 cm^3),
ii) frequency of occurrence for genera and species – number of occurrences of a species in relation to the total number of samples (472) expressed in %.

RESULTS

A total of 119 species belonging to 56 genera were found in soil samples collected in surveyed forest nurseries (Fig. 2, Tables 1–5). Five species were newly found in Poland.

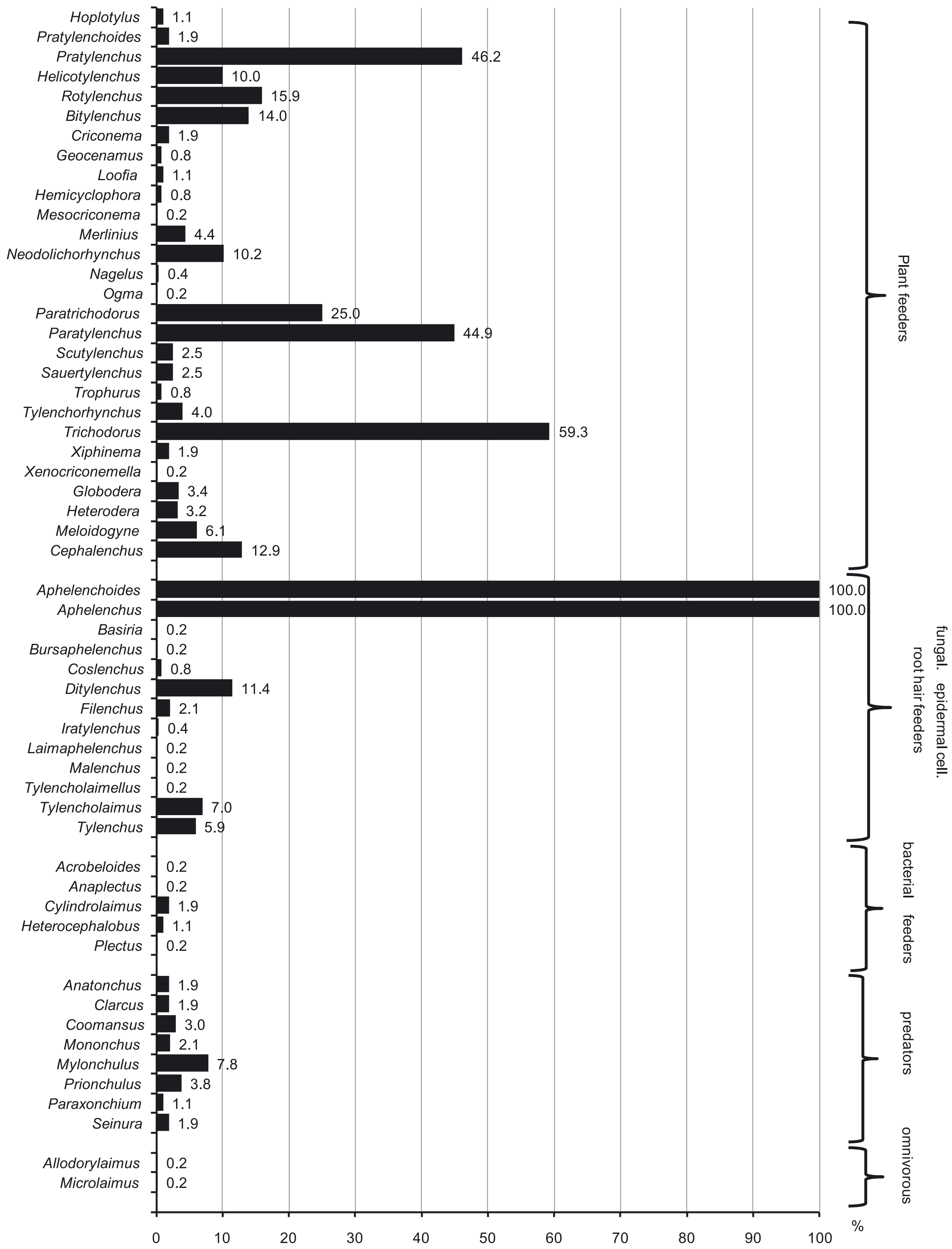

Fig. 2. Frequency of genera (number of occurences expressed in %)

The most frequent were species of two genera: *Aphelenchoides* and *Aphelenchus* which belong to the fungal feeders. The species of the both genera occurred in every sample. Species of *Trichodorus* (59.3%) were very frequent followed by species of *Pratylenchus* (44.9%), *Paratylenchus* (44.9%), *Paratrichodorus* (25,0%), *Rotylenchus* (15,9%), *Bitylenchus* (14%), *Cephalenchus* (12.9%), *Ditylenchus* (11.4%) and *Helicotylenchus* (10%). Most of the species of the mentioned genera belong to the plant feeders. Only the species of *Ditylenchus* are classified as fungal feeding nematodes. Frequency of other genera did not exceed 10% (Fig. 2).

Species composition and maximal density of some species

Migratory endoparasites

Eight species of the family *Pratylenchidae* were found in the soil of the nurseries (Table 1). The highest density of *P. penetrans* was noted in the Tokary nursery in rizosphere of pine seedlings (210 specimens). *P. neglectus* reached high density in a pine nursery in Biechów (180 specimens). *P. crenatus* was very abundant (160 specimens) near spruce rizosphere in a nursery in Osiny, while *P. crenicauda* (120 specimens) in a pine nursery in Równica.

Semiendoparasites

Ten species of the family *Hoplolaiminae* were founded in the investigated nurseries (Table 1). *R. robustus* had a maximal population density of 400 specimens near the root of pine seedlings in the Widek nursery and 215 specimens in Dąbrowa Swiętokrzyska followed by R. goodeyi which achieved a maximal density of 240 individuals. *R. quartus* was less abundant – 180 individuals in rhizosphere of pine seedlings in Rzepin. *R. mesorobustus* was found near the roots of pine seedlings in Ośno Lubuskie.

Ectoparasites

Sixty-six species belonging to twenty-eight genera were found during the study (Table 1). The genus Paratylenchus was represented by ten species. These species are considered as sedentary ectoparasites of different plant species, including tree seedlings (Sutherland and Webster 1993; Brzeski 1998). The most frequent was *P. projectus* which occurred in 22% surveyed nurseries, with a maximal population density of 1200 specimens in soil near rhizosphere of pine seedlings in Gołębiewo. *P. straeleni* occurred only in 7 nurseries, but in high density. A maximum of 210 specimens of *P. straeleni* were found near the roots of spruce seedlings in the Łoś nursery. *P. bukowinensis*, a serious parasite of vegetable crops (Brzeski 1998), also had a high population (180 specimens in 200 cm^3 of soil) in rhizosphere of pine in Białe Błota.

The Telotylenchidae family was represented by fourteen species, belonging to eight genera. The most common was *B. dubius* (frequency 14%) followed by *Neodolichorhynchus microphasmis* (frequency 8%), which inhabits mainly forest soil (Brzeski 1998). The genus *Geocenamus* was represented by *Geocenamus longus* – species characteristic to forest soils according to Sturhan (1981). Another six species of Telotylenchidae rarely occurred (frequency less than 2%). *Scutylenchus rugosus* and *Neodolichorhynchus lammeliferus* were noted for the first time in Poland.

Table 1. Species of plant feeders collected in 209 forest tree nurseries. Trophic groups: Plant feeders: migratory endoparasites, semiendoparasites, ectoparasites, sedentary endoparasites

Family/Genus/Species	Trophic group	Maximal population density (in 200 ccm soil)	Frequency [%]
1	2	3	4
Xiphinematidae			
Xiphinema Cobb, 1913			
diversicaudatum Micoletzky, 1927	A3	40	2
Trichodoridae			
Paratrichodorus Siddiqi, 1974			
pachydermus Seinhorst, 1954	A3	180	20
teres Hooper, 1962	A3	45	5
Trichodorus Cobb, 1913			
cylindricus Hooper, 1962	A3	90	6
primitivus (De Man, 1880)	A3	130	5
similis (Seinhorst, 1968)	A3	30	4
sparsus Szczygieł, 1968	A3	180	20
variopapillatus Hooper, 1963	A3	28	4
viruliferus Hooper, 1963			
Criconematidae			
Criconema Hofmanner & Menzel, 1914			
annuliferum (*De Mann, 1921*)	A3	60	< 1
longulum (Gunhold, 1952)	A3	10	< 1
sphagni (Micoletzky, 1925)	A3	20	< 1
Mesocriconema Andrassy, 1965			
rusticum (Micoletzky, 1915)	A3	120	< 1
Ogma Southern, 1914			
cobbi (Micoletzky, 1915)	A3	40	< 1

1	2	3	4
Xenocriconemella De Grisse & Loof, 1985			
macrodora (Taylor, 1936)	A3	20	< 1
Hemicylciophoridae			
Hemicyliophora De Man, 1921			
triangulum Loos, 1968	A3	120	1
Loofia Siddiqi, 1980			
thienemanni (Schneider, 1925)	A3	120	1
Paratylenchidae			
Paratylenchus Micoletzky, 1922			
bukowinensis Micoletzky, 1922	A3	180	1
dianthus Jenkins et Taylor, 1956	A3	110	3
goodeyi Oostenbrink, 1953	A3	20	< 1
macrodorus (Brzeski, 1963)	A3	40	5
microdorus Andrassy, 1959	A3	120	< 1
nanus Cobb, 1923	A3	110	3
neoamblycephalus Geraert, 1965	A3	36	1
projectus Jenkins,1960	A3	1200	22
straeleni De Coninck, 1931	A3	210	1
veruculatus Wu,1962	A3	180	8
Telotylenchidae			
Bitylenchus Filipjev, 1934			
dubius (*Butschili, 1873*)	A3	410	14
Geocenamus Thorne et Maleh, 1968			
longus (Wu, 1969)	A3	40	< 1
Merlinius Siddiqi, 1970			
brevidens (Allen, 1955)	A3	120	2
joctus (Thorne, 1949)	A3	120	< 1
nothus (Allen, 1955)	A3	130	2
Nagelus Thorne et Malek, 1968			
obscurus (Allen, 1955)	A3	40	< 1
Neodolichorhynchus Jairajpuri & Hunt, 1984			
microphasmis Loof, 1960	A3	130	8
lammelliferus (De Man, 1880)*	A3	20	< 1
Sauertylenchus Sherr, 1974			
maximus (Alllen, 1955)	A3	40	2
Scutylenchus Jairajpuri, 1971			
quadrifer (Andrassy, 1954)	A3	15	< 1
rugosus Siddigi, 1966*	A3	10	< 1
sculptus Loof,1956	A3	12	< 1
tesselatus (Goodey, 1952)	A3	25	< 1
Trophurus Loof, 1956			
sculptus Loof,1956	A3	12	< 1
Heteroderidae			
Heterodera sp Schmidt, 1871	A4	50	3
Globodera Skarbilovich, 1959			
rostochiensis (Wollenweber, 1923)	A4	220	< 1
Hoplolaimidae			
Helicotylenchus Steiner, 1945			
canadensis Wassem, 1961	A2	45	3
digonicus Perry, 1969	A2	75	2
exallus Sher, 1966	A2	36	< 1
pseudorobustus (Steiner, 1914)	A2	130	5
Rotylenchus Filipjev, 1936			
buxophilus Golden, 1956	A2	110	< 1
goodeyi (Loof et Oostenbrink, 1958)	A2	240	4
mesorobustus Zancada, 1985*	A2	20	< 1
pumilis (Perry, 1959)	A2	20	< 1
quartus (Andrassy, 1958)	A2	180	7
robustus (De Man, 1876)	A2	400	3
Meloidogynidae			
Meloidogyne Goeldi, 1892			

1	2	3	4
hapla Chitwood, 1949	A4	800	6
naasi Franklin, 1965	A4	40	< 1
Pratylenchidae			
Hoplotylus Jacob, 1959			
femina Jacob, 1959	A1	15	1
Pratylenchoides Winslow, 1958			
crenicauda Winslow, 1958	A1	120	2
Pratylenchus Filipjev, 1936			
convallariae (*Seinhorst, 1959*)	A1	160	< 1
crenatus Loos, 1960	A1	120	17
fallax Seinhorst, 1968	A1	140	6
flakkensis Seinhorst, 1968	A1	160	3
neglectus (*Rensch, 1924*)	A1	180	3
penetrans (*Cobb, 1977*)	A1	210	11
Pinguicaudatus (*Corbett, 1969*)	A1	120	1
thornei Sher et Allen, 1953	A1	40	2
Tylodoridae			
Cephalenchus Goodey, 1962			
hexalineatus Geraert, 1962	A3	3,180	13

*new to Polish fauna

Hyphal feeders, epidermal cell and root root hair feeders

Thirty four species, belonging to thirteen genera were found (Table 2).

The most frequent species – *Aphelenchus avenae* occurred in 45% of the samples with a maximal density of 850 individuals. Some species of Aphelenchoides were also very frequent; *A. saprophilus* occurred in 21% of the samples, with the maximal density of 2,500 individuals, *A. bicaudatus* was found in 20% of the samples reaching a maximal density 1,200 individuals. *A. composticola* and *A. parietinus* were both observed in 18% of the samples. However, these two species differed significantly with regard to density; maximal density for *A. composticola* was 1,100 individuals, while for *A. parietinus* it was only 180 individuals. Compared to other species of Aphelenchoides, the frequency of *A. fragariae* was a little lower – 16%; maximal density of this species was 400 individuals. Frequency of others species classified as fungal, epidermal cells feeders and root hair feeders did not exceed 13%, and 25 species occurred only in less than 3% of samples. Nevertheless, some species reached a high density, *e.g.* *Ditylenchus anchilisposomus* with 850 individuals.

Table 2. Species of hyphal feeders, epidermal cell and plant root hair feeders collected in 209 forest tree nurseries. Trophic groups: predators, epidermal cell and root hair, fungal feeders

Family/Genus/Species	Trophic group	Maximal population density (in 200 ccm soil)	Frequency [%]
1	2	3	4
Aphelenchoididae			
Aphelenchoides Fisher, 1894			
angusticaudatus Eroshenko, 1968	F	20	2
bicaudatus (Imanura, 1931)	F	1,200	20
composticola Franklin, 1957	F	1,100	18
fragariae (Rizema/ Bastian, 1890)	F	400	16
graminis (Baranowskaja et Hague, 1968)	F	120	10
haquei Maslen, 1979	F	110	12
helophilus (De Man, 1880)	F	12	13
parietinus Bastian, 1865	F	180	18
saprophilus Franklin, 1957	F	2,500	21
Aphelenchidae			
Aphelenchus Bastian, 1865			
avenae Bastian, 1865	F	850	45
eremitus Thorne, 1961	F	500	11
Parasitaphelenchidae			
Bursaphelenchus Fuchs, 1937			
mucronatus Mamiya and Enda, 1999	F	20	< 1
Laimaphelenchus sp Fuchs, 1937	F,C	30	< 1
Anquinidae			
Ditylenchus Filipjev, 1936			

1	2	3	4
anchilisposomus Tarjan, 1958	F	850	1
convallanae Sturhan et Friedman, 1965	F	120	1
dipsaci (Kuhn, 1857)	F	220	< 1
medicaginis Wasilewska, 1965	F	140	3
Tylenchidae			
Basiria Siddiqi, 1959			
graminophila Siddiqi, 1959	F	10	< 1
Coslenchus Siddiqi, 1970			
costatus (De Man, 1921)	F	560	< 1
Filenchus Andrassy, 1954			
nemorosus (Brzeski, 1986)	F	2450	< 1
misellus Andrassy, 1958	F	120	< 1
quartus Szczygieł, 1969	F	200	2
Iratylenchus Kheiri, 1970			
vicinus Szczygieł, 1970	F	20	< 1
Malenchus Andrassy, 1968			
acarayensis, 1965	F	180	< 1
Tylenchus Bastian, 1865			
arcuatus Siddiqi, 1963	F	150	2
davanei Bastian, 1865	F	120	< 1
elegans De Man, 1876	F	180	2
Leptonchidae			
Tylencholaimellus Cobb, 1915			
affinis Brakenhoff, 1914	F	110	1
Tylencholaimidae			
Tylencholaimus De Man, 1876			
crassus Loof and Jairajpuri, 1968	F	100	< 1
formosus Loof et Jairajpuri, 1968	F	30	2
minimus De Man, 1876	F	40	2
proximus Thorne, 1939*	F	30	1
teres Thorne, 1939	F	2	2
davanei Bastian, 1865	F	120	< 1
elegans De Man, 1876	F	180	2

*new to Polish fauna

Predators

Twelve species of eight genera were observed in the nursery soils (Table 3). All species were rather rare; their frequency was, at the most, 3%. Moreover they were not very abundant, the highest density was noticed for *P. punctatus* – 80 individuals in 200 cm^3 of soil.

Table 3. Species of predatory nematodes collected in 209 forest tree nurseries. Trophic group: Predatory nematodes

Family/Genus/Species	Trophic group	Maximal population density (in 200 ccm soil)	Frequency [%]
1	2	3	4
Aporcelaimidae			
Paraxionchum Krall, 1958			
laetifans Andrassy, *1956*	C	30	1
Anatonchidae			
Anatonchus Cobb, 1916			
tridentatus (De Man, 1876)	C	60	2
Mononchidae			
Clarkus Jairajpuri, 1970			
papilatus (Bastian, 1865)	C	10	2
Coomansus Jairajpuri et Khan, 1977			
parvus (de Man, 1880)	C	10	3
Mononchus Bastian, 1865			
aquaticus Coetzee, 1968	C	10	< 1
truncatus Bastian, 1865	C	60	2
Prionchulus (Cobb,1917)			

1	2	3	4
muscorum Dujardin, 1845)	C	10	2
punctatus (Cobb, 1917)		80	2
Mylonchulidae			
Mylonchulus Cobb, 1916			
brevicaudatus (Cobb, 1917)	C	25	3
sigmaturus (Cobb, 1917)	C	10	3
brachyuris (Butschili, 1873)	C	10	2
Seinuridae			
Seinura Fuchs, 1931			
tenuicaudata (*De Man, 1895*)	C	20	2

Omnivorous

Only two species belonging to two genera were found in the analyzed soil samples

(Table 4). They were extremely rare; their frequency was below 1% and density did not exceed 20 individuals in 200 cm^3 of soil.

Bacterial feeders

The nematode of this group were represented by seven species belonging to six genera (Table 5). Frequency of all species was very low and did not exceeded 2%. The highest density was noticed for *Rhabditis* sp. – 180 individuals. The density of *H. elongatus* was much lower – 120 individuals in 200 cm^3 of soil. The densities of others species were very low; no more than 40 individuals.

Table 4. Species of omnivorous nematodes collected in 209 forest tree nurseries Trophic group: Omnivorous

Family/Genus/Species	Trophic group	Maximal population density (in 200 ccm soil)	Frequency [%]
Qudsianematidae			
Allodorylaimus Andrassy, 1983			
andrassyi Meyl, 1955*	D	20	< 1
Microlaimidae			
Microlaimus De Man, 1880			
globiceps De Man, 1880	D	12	< 1

*new to Polish fauna

Table 5. Species of bacterial feeding nematode collected in 209 forest tree nurseries. Trophic group: Bacterial feeders

Family/Genus/Species	Trophic group	Maximal population density (in 200 ccm soil)	Frequency [%]
Diplopeltidae			
Cylindrolaimus De Man, 1880			
communis De Man, 1880	B	40	2
Cephalobidae			
Acrobeloides Cobb, 1924			
nanus De Man, 1880	B	15	< 1
Heterocephalobus Brzeski, 1960			
elongatus (De Man, 1880)	B	120	1
Rhabditidae			
Rhabditis sp. Dujardin, 1845	B	180	2
Plectidae			
Anaplectus De Coninck & Schurmans Stekhoven, 1933			
granulosus (Bastian, 1865)	B	10	< 1
Plectus Bastian, 1865			
cirratus Bastian, 1865*	B	10	< 1
longicaudatus Butschli, 1875*	B	13	< 1

*new to Polish fauna

DISCUSSION

Data obtained in the studies indicate that in forest nursery soils, the most diverse and numerous are species belonging to the fungal feeding group followed by epidermal cells feeders and root hair feeders. Our findings are in accordance with the results obtained by others authors who studied nematodes in forest nurseries (Wasilewska 1971; Wolny 1980; Dobies 2004).

Special attention should be paid to *A. avenae* – a fungal feeding species. First of all, it is a very common species; Wolny found *A. avenae* in 62.5% of samples, Dobies in 23.8 – 7.7% of samples, and in this study this species was noted in 45% of the samples. Moreover, *A. avenae* can achieve high density (for example, in this study – 850 individuals in 200 cm^3 of soil). Thus, common and abundant species should affect the functioning of the environment. This effect is positive when *A. avenae* feed on plant pathogenic fungi – *e.g*. Fusarium, but negative when nematodes feed on mycorrhizal fungi.

In a group of plant feeders, the most common species were: *P. pachydermus* and *T. sparsus* belonging to the Trichodoridae family. Both species occurred in 20% of the samples. *P. pachydermus* was also common in forest nurseries studied by Dobies (2004); it was found in 50% of the soil samples. The species belonging to Trichodoridae could be unsafe for young seedlings because nematodes of this family not only directly damage the root tissue but they can also transmit pathogenic viruses.

Another species, which often occurred in the surveyed nurseries, belongs to the genus *Pratylenchus*. These nematodes feed on cortical tissue causing necrosis on roots. The final effect of feeding by *Pratylenchus* is death of the root system and then death of the whole plant.

The most common species were: *P. crenatus* (17% frequency of occurrence) and *P. penetrans* (11%). This corresponds with the results obtained by Wolny (1973) who found nematodes of *Pratylenchus* in 79.2% of the samples. The harmfulness of *P. penetrans* to tree seedlings is commonly known. This species was responsible for the replanting problem in fruit tree cultivation (Szczygieł 1987; Szczygieł and Zepp 1998). *P. penetrans* is also considered as one of the most dangerous species in forest nurseries, Oostenbrink (1957), Caylor (1959), Hoestra and Oostenbrink (1962) and Bassus (1969).

In this study maximal density of *P. penetrans* was 180 specimens. According to Oostenbrink (1961), fifty individuals of *P. penetrans* in 100 g of soil caused damage to young roots. Therefore, seedlings in the investigated nurseries could be reduced by *P. penetrans.*

Several authors pointed to the harmfulness some species of *Rotylenchus* cause to young tree seedlings (Magnusson 1983; Hijink 1969; Goodey 1965; Tomalak (personal information). Species of *Rotylenchus* are common in Polish nurseries: Dobies (2004) found them in some samples. In this study they occurred in about 16% of samples. Some species achieved high density, *e.g. R. robustus* – 400 individuals in 200 cm^3 of soil. It was much higher than the 20 individuals of *R. uniformis* (according to the system accepted by Fauna Europea *R. uniformis* is a synonim of *R. robustus*) which inhibited development of Sitka spruce seedlings. It can be assumed that the species of *Rotylenchus* could caused losses in forest tree seedlings.

Nematodes belonging to the genus *Paratylenchus* are considered as parasites of forest trees (Suthertland and Webster 1993). They are common in soils of Polish forest nurseries. In this study, the species of *Paratylenchus* occurred in 44.9% of samples. In studies carried out by Wolny (1980) the species of *Paratylenchus* occurred in 45.8% of samples. In this study as well in the one made by Dobies, *P. projectus* achieved high density; about 1200 individuals in 200 cm^3 of soil. It is difficult to estimate whether *P. projectus* found in such an abundance are dangerous for young seedlings because so far we do not know the seedlings' threshold of tolerance for *P. projectus*.

In this study as well as in the study carried out by Dobies (2004), *Cephalenchus hexalineatus* was common and achieved a high density; about 3,000 individuals in 200 cm^3 of soil. Harm caused by C. *hexalineatus* to seedlings has still not been proved. But several experiments were carried out with *C. emarginatus*, a species very close to *C. hexalineatus.* In the seventies, both species were synonimized and then again separated based on the results of molecular analysis (Raski and Geraet 1986). Sutherland (1967) showed that one specimen of *C. emarginatus* can enter the root of a plant 500 times during a 24 hour time period, while Gowen (1971) proved that this species can inhibit seedling development. Does *H. hexalineatus* affect seedlings in the same way?

Nematode communities in this study were characterized by a very low species diversity in the omnivorous group and in the predator group. In 472 samples, only two omnivorous and twelve predatory species were found. In this respect, the communities in forest nurseries resemble those inhabiting arable land (Dmowska 2007), but they differed greatly from communities characteristic for forest soil. For example, Brzeski and Winiszewska-Śliwińska (1996) found 24 predatory species and 16 species considered as omnivorous nematodes in soil of the Białowieża primeval forest.

The bacterial feeding group was also very poor in species. This could be explained by the fact that the abundance of bacterial feeding nematodes is affected by density of bacteria – a food source for this group of nematodes. Bacteria develop well in an environment with organic matter which easily decomposes. This kind of organic matter predominates in cultivated soil (*e.g.* treated with organic manure). And that is why nematode communities inhabiting arable land are rich in species feeding on bacteria. However, organic matter in a soil of forest nurseries is more similar to organic matter in forest soil than to organic matter in a field. In forest soil, organic matter contains a lot of cellulose which is decomposed by fungi – a food source for fungal feeding nematodes. The results of our study indicate that in Polish forest nurseries there occur some species which can cause damage to seedlings *e.g.* species belonging to the family of *Trichodoridae* and *R. robustus, P. penetrans*.

Nematode communities very poor in omnivorous and predatory species indicate that quality of soil in forest nurseries is very low, so seedlings may be less resistant to parasites and pathogens.

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