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NEMATODES OF THE SAND DUNES IN THE KAMPINOS FOREST.

I. SPECIES STRUCTURE

(Ekol. Pol. 18: 429–443). The object of the investigations were the soil nematodes occurring in the afforested dunes of the Kampinos Forest. The studies include a species analysis of the nematofauna and investigation of the effect exerted by plant succession on the dunes, measured by the degree to which the soil is covered by vegetation, by age and differentiation of the tree stand and humus contents in the soil, on the qualitative structure of the nematofauna.

I. INTRODUCTION

Natural habitats have been examined in respect of their settlement by nematodes to a disproportionately smaller degree than cultivated areas, the reason for this being the fact that some nematodes are plant parasites and crop pests. Within the last few years several studies have appeared in world literature on the occurrence of nematodes in forest areas, but none have appeared on the nematofauna of afforested dunes. A far better knowledge has been obtained of the nematodes of coastal dune sands (Overgaard Nielsen 1949, Yeates 1967, 1968). Afforested dunes on the one hand form a separate habitat characterized by poor food resources and a specific microclimate, while on the other the degree of development of the vegetation cover greatly complicates the ecological relations in this habitat. The studies made by Overgaard Nielsen (1949) in Denmark show that both shore beach, and *Calluna heath* and sandy hills covered with *Corynephorus*, are relatively poor in respect of their nematofauna, although habitats on an organic soil are even poorer in this respect.

The investigations described in the present study were concerned with soil nematodes occurring in afforested dunes. Some of these dunes are covered by xerophilous vegetation and scanty tree-stands, while woods grow on others. Analysis was therefore made of a sequence of dunes in a gradient of increasingly dense vegetation cover and consequently in a gradient of humus contents in the soil. The study by Overgaard Nielsen (1949) has been taken as a basis in this case, since it showed that the degree to which the soil is covered by vegetation affects the qualitative and quantitative relations of the nematofauna. A preliminary analysis was made in the Kampinos Forest of nematode communities in dune, meadow and forest habitats and also in the potato fields adjacent to the Forest (Sandner, Wasilewska in press). It was found, inter alia, that the factor significantly differentiating the numbers of nematodes in the dune habitat was the soil humus content. I concentrated my studies of dune nematodes on the following:

1. species analysis of the nematodes of afforested dune habitats as a whole,
2. dependence of the qualitative structure on plant succession on the dunes, and thus on the degree of vegetation cover and soil humus contents,
3. dependence of the qualitative structure and nematofauna biomass on plant succession.

The present publication includes the results of studies carried out in respect of the first two problems. As it is proposed to elaborate the concepts of genus and ecological group in subsequent publications, I considered it desirable to keep the part devoted solely to species analysis quite separate.

II. STUDY AREA

It was possible to find dune areas varying in the degree to which plant succession had advanced in the south-eastern part of the Kampinos Forest. On the dune slopes facing south, which were in fact the slopes examined, succession tends in the direction of mixed forests. Primeval tree stands of this type still cover certain parts of the dune areas of the Forest. Secondary succession, which took place after the trees had been felled on the dune areas, was hastened by artificial afforestation, chiefly by pines. Nevertheless it is still possible at the present time to find dunes on which vegetation constitutes different stages of succession tending to the formation of natural mixed forests.

Six working stations were chosen, 5 of which could be arranged in order of the degree to which succession had advanced, from a dune almost devoid of vegetation to a dune covered by a natural tree stand of many species. The distance between the stations varied from 3.5 km to 8 km.

Faintly podzolised soils, formed of loose dune sand, occur on the dunes in the Kampinos Forest. They are poor in food components, dry, well aerated and easily permeated (Czerwiński 1965). Decomposition of the organic substance of forest litter takes place very slowly in soils of this type. The various stations are differentiated chiefly by the humus contents, which were determined in soil samples taken down to a depth of 25 cm. A floristic description of the working stations is given below:

Station A. A small dune area situated near the Field Station of the Institute of Ecology, Polish Academy of Sciences, at Dziekanów Leśny. Six years previously (counting from the period when studies were initiated, i.e. 1962) the bare dune had been planted with pine (*Pinus silvestris* L.) and birch (*Betula verrucosa* Ehrh.). Apart from the grass-clumps of *Corynephorus canescens* (L.) P.B. the dune area is mainly open.

Station B. A high dune between the villages of Pociecha and Truskaw. The area is covered by 10-year old pine trees (*Pinus silvestris*) and juniper (*Juniperus communis* L.), while the following species occur in small numbers and in clumps in the herb layer: *Corynephorus canescens*, *Thymus serpyllum* L. and mosses.

Station C. A high dune near the Łuże marsh, covered chiefly by 10-year old pine trees (*Pinus silvestris*) and juniper (*Juniperus communis*) and several oaks (*Quercus robur* L.). The herb layer, which is far richer than on the previous station, consists of the following: *Corynephorus canescens*, *Festuca ovina* L., *Poa compressa* L., *Carex ericetorum* Poll., *Euphorbia cyparissias* L., *Pulsatilla pratensis* (L.) Mill., *Spergula vernalis* Willd., *Rumex acetosella* L., *Calluna vulgaris* (L.) Salisb., *Hieracium pilosella* L., *Dianthus arenarius* L., *Peucedanum oreoselinum* (L.) Moench., *Veronica Dillenii* Cr., mosses and lichens.

Station D. A dune near the village of Sieraków. The tree stand on the dune is richer than on the preceding stations and consists chiefly of pine (*Pinus silvestris*) about 8, and from 17–20 years old, and juniper (*Juniperus communis*), and also oak several years old (*Quercus robur*) and birch (*Betula verrucosa*). The herb layer includes the following plants: *Calamagrostis epigeios* (L.) Roth., *Corynephorus canescens*, *Festuca rubra* L., *Achillea millefolium* L., *Solidago virga-aurea* L., *Rumex acetosella*, *Sedum maximum* Sut., *Calluna vulgaris*, *Peucedanum oreoselinum*, *Euphorbia cyparissias*, *Thymus serpyllum*, *Senecio vulgaris* L., *Polygonatum odoratum* (Mill.) Druce, *Dianthus arenarius* L., mosses and to a lesser degree lichens.

Station E. A high dune elevation known as Wywrotnia Góra, on which a natural multi-species tree stand has formed, which is an advanced stage of the succession found in the sequence of associations growing on the dunes in the Kampinos Forest. The study area of this part of the Forest was covered by an association similar in type to *Potentillo albae – Quercetum* (Libbert 1933). The average age of the tree stand was 135 years, and the species of trees there were oak (*Quercus robur*), pine (*Pinus silvestris*) and in the undergrowth young hornbeam (*Carpinus betulus* L.) and lime (*Tilia cordata* Mill.) while the shrub layer consisted of *Corylus avellana* L., *Frangula alnus* Mill. and *Juniperus communis*. The species composition of the herb layer is very rich.

Station F. A fairly extensive dune area, on which a dry pine forest has formed, near the gamekeeper's house at Pociecha. A homogeneous plant association – *Cladonio – Pinetum* (Kobendza 1930) occurred over the whole area. The tree stand consisted of pines about 135 years old (*Pinus silvestris*), practically without undergrowth. The herb layer consisted mainly of lichens and to a lesser degree mosses, occupying more than 80% of the surface not occupied by trees. The following herbs grew in small numbers and in clumped distribution: *Calluna vulgaris*, *Rumex acetosella*, *Polygonatum odoratum*, *Convallaria maialis* L., *Festuca ovina*, *Corynephorus canescens* and *Agrostis vulgaris* With.

Humus contents, age of the tree stand and degree of its species differentiation, degree of species differentiation of the herb layer and degree of cover by vascular plants were taken as criteria in arranging the stations in order in

Ecological description of working stations

Tab. I

Working station	*A*	*B*	*C*	*D*	*E*	*F*
% of total humus in soil	0.24	0.40	1.25	1.58	2.13	2.29
Age of pine stand	6	10	12	17–20	135	135
Number of species of trees and shrubs	2	2	3	4	7	1
Number of species of vascular plants	2	4	15	16	>30	7
% of cover by vascular plants	10	22	27	48	55	10
% of moss and lichen cover	8	6	17	35	10	82

the succession sequence. The above parameters increased in accordance with the arrangement accepted on the five stations as follows: *A B C D* and *E*, the degree of cover by lichens and mosses, which was measured separately, varied (Tab. I). In addition to the sequence distinguished, it was necessary to consider station *F* (dry pine forest) which, although characterized by old tree stand and high humus contents, was on the other hand a tree stand without variety, and only a low percentage of the cover in the lichen layer was formed by vascular plants. This station was therefore used for the purpose of demonstrating the importance of vascular plants to the occurrence of nematodes.

III. METHODS

The investigations were made during the growing season of 1968 and winter of 1969, on the basis of samples taken six times during this period. Soil samples were taken on each of the working stations by soil samplers, the cylindrical soil container of which was 1,5 cm in diameter and 25 cm long. Daily variations in soil temperature on the dunes are considerable in the superficial layer, but are not generally as great at a depth of 10 cm (data after Kobendzina 1966 referring to a bare dune). Hence sampling to a depth of 25 cm should in principle free the result of any possible daily vertical migration of nematodes caused by soil temperature fluctuations. A sample consisted of 20 samplings taken on the axis from the apex of the dune to its foot along the southern or south-east slope. Endeavour was made to carry out sampling as far as possible in the same place in different periods. Several small portions were taken from the soil obtained in this way in order to extract nematodes by means of the modified Baermann method, and simultaneously by the centrifugal method. Quantitative analysis of nematodes was made on the basis of at least four small samples 25 ml in volume. Species identification was carried out on samples taken in July, August and October, supplementing the list of species as required by the results of later sampling.

IV. ANALYSIS OF THE OCCURRENCE OF NEMATODE SPECIES

The names of species of nematodes have in principle been given in conformity with Goodey's systematics (1963), but include more recent findings by the following authors: Anderson (1968), Andrassy (1966, 1967, 1968), Brzeski (1962, 1963a and 1963b), Geraert (1966), de Grisse (1967), de Grisse, Loof (1965), Hooper (1963), Loof (1968), Siddiqi (1963) and Wasilewska (1965a, 1965b and in press).

A total number of 107 species of nematodes were found to occur on the working stations (Tab. II). The species name has not been used in relation to 18 species, either due to the fact that some of them are being prepared for description by other authors, or that these are species probably new to science but not as yet described, or simply on account of difficulty in identifying them. Among the species found 19 were discovered for the first time in Poland, and are thus new to Polish fauna. *Aphelenchoides dubius* is new to science and the description of this species is to be found in a separate publication

List of nematode species of the afforested dunes of the Kampinos Forest

x – occurs in small numbers, xx – occurs in numbers over 60 individuals per 100 ml of soil, * species new to Polish fauna

Tab. II

No.		A	B	C	D	E	F
1	2	3	4	5	6	7	8
1	*Aglenchus agricola* (de Man, 1884), Meyl, 1960	x	x	xx	x	x	x
2	*Malenchus acarayensis* Andrassy, 1968*	–	–	–	–	x	–
3	*Tylenchus baloghi* Andrassy, 1958	–	–	–	–	x	–
4	*T. davainei* (Bastian, 1865) Filipjev, 1934	–	–	x	x	–	–
5	*T. ditissimus* Brzeski, 1963	x	x	x	xx	xx	xx
6	*T. leptosoma* de Man, 1880	–	x	–	x	x	–
7	*T. minutus* Cobb, 1893	–	–	x	–	xx	x
8	*T. parvus* Siddiqi, 1963	–	–	x	–	–	–
9	*T. polyhypnus* Steiner, Albin, 1946	–	–	–	x	–	–
10	*T. sandneri* Wasilewska, 1965	–	–	x	–	–	–
11	*T. vulgaris* Brzeski, 1963	–	–	x	x	x	x
12	*Tylenchus* "1"	–	–	–	x	x	–
	Tylenchus sp.	x	–	x	–	x	–
13	*Tetylenchus joctus* Thorne, 1949*	–	x	x	x	–	–
14	*Psilenchus* sp.	–	–	x	–	–	–
15	*Tylenchorhynchus brevidens* Allen, 1955	–	x	xx	x	–	–
16	*T. dubius* (Buetschli, 1873) Filipjev, 1936	–	x	x	x	x	x
17	*T. leptus* Allen, 1955*	–	–	x	–	–	–
18	*T. microdorus* Geraert, 1966	–	–	x	–	–	–
19	*T. microphasmis* Loof, 1959*	x	x	x	x	x	x
20	*Tylenchorhynchus* "1"	x	–	–	x	–	–
21	*Tylenchorhynchus* "2" *	x	–	–	x	x	x
22	*Ditylenchus dipsacoideus* (Andrassy, 1952) Andrassy, 1956	–	–	–	x	–	–
23	*D. intermedius* (de Man, 1880) Filipjev, 1936	x	x	x	x	x	x
24	*D. medicaginis* Wasilewska, 1965	x	x	x	x	x	x
25	*D. myceliophagus* J.B. Goodey, 1958	x	x	x	x	–	–
26	*Pseudhalenchus minutus* Tarjan, 1958*	–	x	–	x	–	–
27	*Meloidogyne* sp.	–	x	x	x	x	–
28	*Helicotylenchus pseudorobustus* (Steiner, 1914) Golden, 1956	x	x	x	–	x	–
29	*Rotylenchoides* sp.	–	–	–	–	x	–
30	*Pratylenchus crenatus* Loof, 1960	x	–	–	–	x	–
31	*P. penetrans* (Cobb, 1917) Chitwood, Oteifa, 1952	–	–	–	x	–	–
32	*P. pratensis* (de Man, 1880) Filipjev, 1936	–	–	x	–	–	–
33	*Hemicycliophora epicharoides* Loof, 1968*	x	x	x	x	x	–
34	*Nothocriconema loofi* de Grisse, 1967*	–	–	–	–	x	–
35	*N. princeps (Andrassy, 1962)* de Grisse, Loof, 1965*	–	–	–	–	x	–

1	2	3	4	5	6	7	8
36	*Macroposthonia curvata* Raski, 1952	–	–	–	–	x	–
37	*Xenocriconemella macrodora* (Taylor, 1936) de Grisse, Loof, 1965*	–	–	–	–	x	–
38	*Paratylenchus goodeyi* Oostenbrink, 1953	–	x	–	–	–	–
39	*P. microdorus* Andrassy, 1959	–	–	–	x	–	–
40	*P. projectus* Jenkins, 1956	x	–	–	–	–	–
41	*P. steineri* Golden, 1961	–	x	–	–	–	–
42	*Nothotylenchus exiguus* Andrassy, 1958*	–	–	x	x	–	–
43	*Aphelenchus avenae* Bastian, 1865	x	x	x	x	x	x
44	*Aphelenchoides bicaudatus* (Imamura, 1931) Fil., Sch. Stek., 1941	–	x	–	x	x	x
45	*A. dubius* Wasilewska, 1969*	–	x	xx	x	xx	x
46	*A. goeldi* (Steiner, 1914) Fil., Sch. Stek., 1941	–	x	x	x	xx	x
47	*A. saprophilus* Franklin, 1957	x	xx	xx	xx	xx	xx
48	*Aphelenchoides* "1"	–	–	–	–	x	–
49	*Aphelenchoides* "2"	–	–	x	–	–	–
	Aphelenchoides sp.	–	–	–	–	x	–
50	*Paraphelenchus pseudoparietinus* (Micoletzky, 1922) Micoletzky, 1925	x	x	x	x	x	x
51	*Diplogaster* s. l. spp.	–	–	–	x	–	–
52	*Rhabditid* s. l. spp.	–	x	x	x	x	x
53	*Panagrolaimus rigidus* (Schneider, 1866) Thorne, 1937	x	x	x	x	x	x
54	*Eucephalobus mucronatus* (Kozłowska, Roguska-Wasilewska, 1963) Andrassy, 1967	–	x	x	x	x	x
55	*E. striatus* (Bastian, 1865) Thorne, 1937	–	–	x	x	x	x
56	*Cephalobus persegnis* Bastian, 1865	x	x	x	x	x	x
57	*Heterocephalobus elongatus* (de Man, 1880) Andrassy, 1967	–	x	x	x	x	x
58	*Acrobeloides nanus* (de Man, 1880) Anderson, 1968	x	xx	xx	xx	xx	xx
59	*Chiloplacus symmetricus* (Thorne, 1925) Thorne, 1937	–	x	x	x	x	x
60	*Zeldia punctata* (Thorne, 1925) Thorne, 1937*	x	x	x	x	x	–
61	*Cervidellus serratus* (Thorne, 1925) (Thorne, 1937)	x	x	xx	x	x	x
62	*Acrobeles ciliatus* Linstow, 1877	x	xx	xx	xx	x	x
63	*Teratocephalus terrestris* (Buetschli, 1873) de Man, 1876	–	x	x	x	x	x
64	*Plectus assimilis* Buetschli, 1873*	–	–	–	x	x	–
65	*P. cirratus* Buetschli, 1865	–	–	x	–	–	–
66	*P. geophilus* de Man, 1880	–	x	–	–	–	–
67	*P. longicaudatus* Buetschli, 1873	–	–	xx	x	x	x
68	*P. parietinus* Bastian, 1865	–	–	x	–	x	x
69	*P. parvus* Bastian, 1865	x	xx	xx	xx	xx	xx
70	*Anaplectus granulosus* (Bastian, 1865) de Coninck, Sch. Stek., 1933	–	–	–	x	x	–

Tab. II (con.)

1	2	3	4	5	6	7	8
71	*Wilsonema auriculatum* (Buetschli, 1873) Cobb, 1913	—	—	x	x	x	x
72	*W. otophorum* (de Man, 1880) Cobb, 1913	—	x	xx	x	xx	x
73	*Rhabdolaimus terrestris* de Man, 1880	—	x	x	x	x	x
74	*Cylindrolaimus communis* de Man, 1880	x	x	x	x	x	x
75	*Monhystera villosa Buetschli*, 1873	x	x	x	x	x	x
76	*Prismatolaimus intermedius* (Buetschli, 1873) de Man, 1880	x	x	xx	x	x	x
77	*Tripyla affinis* de Man, 1880	—	x	x	x	x	—
78	*Mesodorylaimus bastiani* (Buetschli, 1873) Andrassy, 1959	—	x	—	—	x	x
79	*Eudorylaimus carteri* (Bastian, 1865) Andrassy, 1959	x	—	—	—	—	—
80	*E. granuliferus* (Cobb, 1893) Andrassy, 1959*	—	x	x	x	—	—
81	*E. iners* (Bastian, 1865) Andrassy, 1959	x	x	x	x	x	x
82	*E. intermedius* (de Man, 1880) Andrassy, 1959	—	—	x	x	—	—
83	*E. monohystera* (de Man, 1880) Andrassy, 1959	—	—	—	x	—	—
84	*E. obtusicaudatus* (Bastian, 1865) Andrassy, 1959	x	x	xx	xx	xx	x
85	*E. parvulus* (Thorne, Swanger, 1936) Andrassy, 1959*	—	—	—	—	x	—
86	*E. pratensis* (de Man, 1880) Andrassy, 1959	x	x	—	—	—	—
87	*E. productus* (Thorne, Swanger, 1936) Andrassy, 1959	—	—	x	x	—	—
88	*E. silvaticus* Brzeski, 1960	—	—	—	—	x	x
89	*Eudorylaimus* "1"	x	—	—	x	—	—
90	*Eudorylaimus* "2"	x	—	—	—	—	—
91	*Eudorylaimus* "3"	—	x	—	—	x	—
92	*Thornia* sp.	—	—	—	—	x	—
93	*Drepanodorus* sp.	—	—	—	x	—	x
94	*Tylencholaimus mirabilis* (Buetschli, 1873) de Man, 1876	x	x	xx	xx	xx	x
95	*Longidorus.* sp.	—	—	x	x	—	—
96	*Xiphinema* sp.	—	—	x	—	—	—
97	*Enchodorella macramphis* (Altherr, 1950) Siddiqi, 1964*	—	—	x	—	—	—
98	*Dorylaimellus demani* J.B. Goodey, 1963	—	x	x	x	x	—
99	*Mononchus papillatus* Bastian, 1865	—	—	—	x	x	—
100	*Iotonchus* sp.	—	—	—	—	x	—
101	*Alaimus parvus* Thorne, 1939	—	x	x	—	—	x
102	*A. primitivus* de Man, 1880	—	—	x	x	x	—
103	*A. simplex* Cobb, 1914	—	—	x	—	—	—

Tab. II (con.)

1	2	3	4	5	6	7	8
104	*Diphtherophora obesus* Thorne, 1939*	x	–	x	x	x	x
105	*Trichodorus christiei* Allen, 1957	–	x	–	–	–	–
106	*T. pachydermus* Seinhorst, 1954	x	x	–	x	–	–
107	*T. viruliferus* Hooper, 1963	–	–	–	–	x	–
	Trichodorus sp.	–	–	x	–	–	x

(Wasilewska 1969). *Tylenchorhynchus* "2" was distinguished from the other known species of the genus *Tylenchorhynchus* by its very long stylet (from 60 μ to 66 μ). Dr. Loof of Wageningen is preparing a description of this species on the basis of his material found in Holland. *Malenchus acarayensis* has been described on the basis of individuals found in Paraguay (Andrassy 1968) and its present discovery in Poland is simultaneously the first time it has been found in Europe. Until recently the systematic position of the species *Acrobeloides nanus* (de Man, 1880), Anderson, 1968 was an interesting question. Anderson (1968) transferred *Cephalobus nanus* de Man, 1880 to the genus *Acrobeloides* (Cobb, 1924) Steiner, Buhrer, 1933, and in addition gave *Acrobeloides buetschlii* (de Man, 1884) Steiner, Buhrer, 1933, as synonymous with *C. nanus*. *Acrobeloides nanus* sensu Anderson, 1968 exhibits great morphological variation, depending on its habitat conditions, as has been demostrated by the analyses of many populations obtained from field conditions and from cultures (Anderson 1968). On the basis of the description and drawings of the extreme and intermediate forms of this species given in Anderson's revelationary study (1968), I reached the conclusion that the species *Acrobeloides setosus* Brzeski, 1962 fits the description of *Acrobeloides nanus* sensu Anderson, 1968 and is its synonym. I should like to emphasise at the same time that the species *A. nanus* (de Man, 1880), Anderson, 1968, referred to in this study, includes the species treated separately by me in my previous paper (Wasilewska 1967a): *Cephalobus nanus* de Man, 1880, *Acrobeloides buetschlii* (de Man, 1884) Steiner, Buhrer, 1933 and *A. setosus* Brzeski, 1962.

Hemicycliophora epicharoides Loof, 1968 has recently been described from the sandy dune soil in Holland and has not recorded since that time. Dr. Loof kindly confirmed my identification.

On the basis of the list given in Table II it was established that 21 species of nematodes were common to six of the dune stations, and the next 11 species were common to five stations. The first group of species includes those which occurred in decidedly greater quantitative concentration than all the others, at least on the majority of the stations. They form the core of the soil nematode community in the afforested dune habitat. They are:

1. *Tylenchus ditissimus*
2. *Aphelenchoides saprophilus* – feeders on higher plants and fungi

3. *Acrobeloides nanus*
4. *Acrobeles ciliatus* – bacterial feeders
5. *Plectus parvus*

6. *Eudorylaimus obtusicaudatus*
7. *Tylencholaimus mirabilis* – omnivorous feeders

The combined number of individuals of these species formed about 50% of the numbers of the whole nematode community on each of the stations, and on these grounds they can be considered as dominants. These dominants are thus representatives of the chief ecological groups of nematodes, with the exception of typical plant parasites, despite the fact that species of this group figure in the faunistic list.

As established by Overgaard Nielsen (1949), the nematofauna of each habitat consists of eurytopic components and the group of species closely connected with the type of soil. The author's studies show that on typical sandy soils with dense plant cover eurytopic species form about 90% of the whole nematode community. On the dune working stations which I examined the majority of the dominants were eurytopic species such as *Tylenchus ditissimus*, *Aphelenchoides saprophilus*, *Acrobeloides nanus*, *Plectus parvus* and *Eudorylaimus obtusicaudatus*. The other two dominants, *Acrobeles ciliatus* and *Tylencholaimus mirabilis* are, as Overgaard Nielsen found, stenotopic species and their occurrence as dominants is connected with the typical sandy soil. As confirmation of the latter phenomenon the fact may be mentioned here that *T. mirabilis* was not found to occur in soil of the brown type under an alfalfa crop near the Kampinos Forest, while *A. ciliatus* did not occur as a dominant (Wasilewska 1967b). Information is given in another study (Sandner, Wasilewska in press) that individuals of the genus *Acrobeles*, later identified by me as *A. ciliatus*, occurred numerously only in the dune habitat,while they were either absent or occurred in minimal numbers in forest, meadow and potato field habitats.

Overgaard Nielsen (1949) gives a similar species composition of dominants in sandy and poor habitats in Denmark. The main components of the soil nematode communities of these habitats were *Eudorylaimus obtusicaudatus*, *Tylencholaimus mirabilis*, *Acrobeles ciliatus* and *Cephalobus nanus*. The great majority of the species (apart from the above dominants) given by Overgaard Nielsen for these habitats were also found in analysed by me afforested dune habitat.

V. INFLUENCE OF PLANT SUCCESSION ON DIFFERENTIATION OF THE NEMATODE COMMUNITY

As already stated, the dunes were chosen for the studies formed as sequence from the poorest to increasingly rich in respect of vegetation and humus content. Let us consider whether this is also reflected in the increasing variety of the species composition of the nematodes. For this purpose a list is given in Table III of the numbers of species on each station. When the extreme stations from *A* to *E* are compared it will be found that the number of species on the dune with 10% vascular plant cover and 0.24% humus content in the soil was twice lower than on the dune covered by mixed forest, with 55% cover and 2.13% humus contents. On the other hand the number of species on station *E* (the cover 55%, humus contents 2.13%) and station *C* (the cover 27%, humus contents 1.33%) is similar. This leads to the conclusion that the threshold settlement conditions for the majority of nematode species in a afforested dune habitat occur when the cover of the dune by vascular plants is not less than about 25% and humus content in the soil not less than 1%. On stations in which humus contents were over 1% and degree of vascular plant cover higher than 25% (stations *C*, *D* and *E*) a similar total number of species and similar percentages of the number of species from different ecological groups were found irrespective of the age of the tree stand and even independently of the species differentiation of the plant cover (Tab. I and III). On station *F* (dry pine forest) the number of nematode species was smaller than on four stations in the succession sequence (Tab. III). As already men-

Participation of number of species from different ecological groups in the nematode community on different working stations

Tab. III

Working station / Ecological group	A number of species	A %	B number of species	B %	C number of species	C %	D number of species	D %	E number of species	E %	F number of species	F %
Feeders oh higher plants and fungi	16	46	24	46	31	47	31	46	30	45	17	38
Bacterial feeders	9	27	17	33	21	32	22	32	22	33	19	42
Omnivorous feeders	9	27	10	19	13	20	13	19	12	18	9	20
Predators			1	2	1	1	2	3	3	4		
Total	34	100	52	100	66	100	68	100	67	100	45	100

tioned, the dry pine forest is a specific habitat – a single-species tree stand, without undergrowth, with poor lichen layer and high humus contents. The degree of vascular plant cover was low on this station – 10% (Tab. I). It probably played an important role in limiting the occurrence of species, chiefly of the group of feeders on higher plants and fungi, but affected species of the other ecological groups to a lesser degree. This is clear when comparison is made of the number of species on stations *E* and *F*, on which the vascular plant cover differed the most (55% and 10%), while the humus content in the soil was similar. The number of species from the group of feeders on higher plants and fungi was 30 on station *E*, 17 on station *F*, and for the group of bacterial feeders respectively 22 and 19 and for the group of omnivorous feeders – 12 and 9.

The degree of moss and lichen cover did not play as important a part as the degree of vascular plant cover.

Species belonging to all ecological groups of nematodes were included in the composition of the afforested dune nematofauna (Tab. III). The largest number were species feeding on higher plants and fungi, and they formed almost 50% of the whole number of species on the dunes. The dominants in this group were not, however, the typical parasites of higher plants, but as mentioned previously, a mycophilous species and a species which was probably a facultative parasite. I applied this latter term to the representative of the genus *Tylenchus* s.l., which has in fact been reported as parasitizing the roots of higher plants, but it is not known if this is their only feeding habit. Bacterial feeders also had numerous representatives on the species list of the stations examined and three of the dominants belong to this group. The total number of species of feeders on higher plants and fungi and the bacterial feeder group formed about 80% of the number of all species found on the dunes. It was in these two groups that the increase in number of species proceeding with greater advance in plant succession was clearly evident. In the group of omnivorous feeders, which is fomed chiefly by Dorylaims, the variations in number of species in the succession sequence of stations was far smaller. This is probably evidence that increase in humus contents in the soil and soil cover by plants contributed to increase in species differentiation in this group to a far lesser degree than in the first two groups of nematodes. Predatory species formed a very low percentage of the total number of species.

VI. CONCLUSIONS

1. 107 species of nematodes were found to occur in the afforested dunes of the Kampinos Forest. 19 species proved to be new to Polish nematofauna, and one of these new to science (description in a separate publication).

2. The following species were dominants: *Tylenchus ditissimus*, *Aphelenchoides saprophilus*, *Acrobeloides nanus*, *Acrobeles ciliatus*, *Plectus parvus*, *Eudorylaimus obtusicaudatus* and *Tylencholaimus mirabilis*. 5 eurytopic and 2 stenotopic species i.e. *A. ciliatus* and T. *mirabilis* were included in the number of dominants.

3. Similarity was found between the species composition of nematodes in these sand dunes and in habitats of similar type in Denmark. It was assumed that the poor natural habitats on sandy soils in North and Central Europe are characterized by similar species composition.

4. Increase in the degree of vascular plant cover of the dunes and increase in soil humus contents contribute to a wider variety of nematode species. The low degree of vascular plant cover, even when there is a relatively large humus content in the soil, limits the occurrence of many species, mainly those belonging to the group of feeders on higher plants and fungi. The degree of moss and lichen cover does not play as important a part as the vascular plant cover.

For the majority of nematode species in the afforested dune habitat the threshold settlement conditions occur with a degree of vascular plant cover of not less than about 25% and soil humus content of not less than about 1%.

5. The largest number of nematode species on afforested dunes belonged to the group of feeders on higher plants and fungi, the number of species belonging to the bacterial feeder group being smaller. Increase in the number of species taking place with increased advance in plant succession is evident mainly in these two groups. Increase in the number of species belonging to the omnivorous feeder groups (mainly Dorylaims) was negligible. This would mean that the species in the last group depend to a lesser degree on the plant cover of the dune and soil humus contents.

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NICIENIE WYDM PUSZCZY KAMPINOSKIEJ. I. STRUKTURA GATUNKOWA

Streszczenie

Praca dotyczy badań nad nicieniami glebowymi występującymi na wydmach zalesionych w południowo-wschodniej części Puszczy Kampinoskiej. Ustalono skład gatunkowy nematofauny i wyróżniono dominanty zasiedlające sześć stanowisk tego środowiska. Przeanalizowano również zależność struktury jakościowej zgrupowania nicieni od sukcesji roślinnej na wydmach, począwszy od wydmy niemal pozbawionej roślinności do wydmy pokrytej naturalnym wielogatunkowym drzewostanem. Kryterium uszeregowania stanowisk w ciąg sukcesyjny stanowiła zawartość próchnicy, wiek drzewostanu i stopień jego zróżnicowania gatunkowego, stopień zróżnicowania gatunkowego runa oraz stopień pokrycia przez roślinność (Tab. I). Zmiany w strukturze ilościowej oraz w biomasie nematofauny zależne od sukcesji roślinnej będą tematem następnej publikacji. W ramach niniejszej publikacji wysunięto następujące wnioski:

1. Na zalesionych wydmach Puszczy Kampinoskiej stwierdzono występowanie 107 gatunków nicieni. 19 gatunków okazało się nowych dla nematofauny Polski, z tego jeden nowy dla nauki, opisany w oddzielnej publikacji (Tab. II).

2. Dominantami były następujące gatunki: *Tylenchus ditissimus*, *Aphelenchoides saprophilus*, *Acrobeloides nanus*, *Acrobeles cilatus*, *Plectus parvus*, *Eudorylaimus obtusicaudatus* i *Tylencholaimus mirabilis*. W skład dominantów wchodziło 5 gatunków eurytopowych i 2 stenotopowe, a mianowicie *A. ciliatus* i *T. mirabilis*.

3. Stwierdzono podobieństwo składu gatunkowego nicieni badanych wydm i zbliżonego typu środowisk w Danii. Wysunięto przypuszczenie, iż ubogie środowiska naturalne na podłożu gleb piaszczystych w Europie północnej i centralnej charakteryzują się zbliżonym składem gatunkowym.

4. Wzrost stopnia pokrycia wydm przez rośliny naczyniowe i wzrost zawartości próchnicy w glebie przyczynia się do wzbogacenia gatunkowego nematofauny. Niski stopień pokrycia przez rośliny naczyniowe nawet przy stosunkowo dużej zawartości próchnicy w glebie ogranicza występowanie wielu gatunków, głównie zaś z grupy odżywiającej się kosztem roślin wyższych i grzybów. Stopień pokrycia przez mchy i porosty nie odgrywa takiej roli jak stopień pokrycia przez rośliny naczyniowe.

W środowisku wydm zalesionych dla większości gatunków nicieni progowe warunki zasiedlenia się występują przy stopniu pokrycia wydmy przez rośliny naczyniowe nie mniejszym niż około 25% i przy zawartości próchnicy w glebie nie mniejszej niż około 1% (Tab. I i II).

5. Największa liczba gatunków nicieni na wydmach zalesionych należała do grupy odżywiającej się kosztem roślin wyższych i grzybów. Mniejsza od niej liczba gatunków należała do grupy odżywiającej się bakteriami. Wzrost liczby gatunków postępujący wraz z zaawansowaniem sukcesji roślinnej zaznaczał się głównie w tych dwóch grupach. Wzrost liczby gatunków z grupy wszystkożernych (głównie *Dorylaimida*) był nieznaczny (Tab. III). Oznaczałoby to, iż gatunki ostatniej grupy są w mniejszym stopniu uzależnione od pokrycia wydm przez rośliny naczyniowe i zawartości próchnicy w glebie.

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