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ANALYSIS OF THE OCCURRENCE OF NEMATODES IN ALFALFA CROPS
I. SPECIES COMPOSITION OF NEMATODES IN TWO ALFALFA CROPS OF DIFFERENT AGE AND PENETRATION OF SPECIES FROM SOIL TO PLANTS*

Analysis was made of the qualitative and quantitative composition of the nematodes occurring in plants and soil in two alfalfa crops situated in the Warsaw district. The aim of the first part of this study was: 1) to determine the full species composition of the nematodes occurring in the two crops (younger and older), which would at the same time permit of obtaining a knowledge of the variety of ecological forms of these nematodes and 2) to compare the intensity of occurrence of species in the upper parts of the alfalfa plants, in roots and in the soil, that is, to assess the penetration of different species from soil to plants.

Contents

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I. INTRODUCTION

Seed alfalfa (*Medicago sativa* L.) as a perennial presents far greater opportunities for nematodes to occur in it than in annual crops. This fact was emphasised by Tulaganov (1950) and Deubert (1959). In perennial crops in addition a large amount of organic residues accumulate in the soil, which form food supplies for many groups of nematodes connected with plants (Deubert 1959). This is further borne out by the more intensive occurrence of nematodes in older alfalfa crops than in younger ones (Tulaganov 1949, Karimova 1957).

Research on the nematofauna of cultivated plants, simultaneously including all ecological groups of nematodes and treating them from the quantitative aspect, is of fairly recent date. The nematofauna of alfalfa crops has not as yet been adequately examined. Apart from several reports recording the occurrence of species harmful to alfalfa chiefly *Ditylenchus dipsaci* (Kühn 1857) Filipjev 1936, there are no complete elaborations of the nematodes of this crop to be found in literature until the 30^{s} of the present century. Kirjanova (1935), Tulaganov (1941, 1949, 1950, 1952), Belaeva (1949, 1951) and Karimova (1957) examined the nematofauna of alfalfa, investigating simultaneously the nematodes occurring in the upper parts of plants, the roots and the soil round the roots. This permitted them to ascertain the species composition and intensity of occurrence of nematodes in crops in several regions of the Soviet Union. In Germany Paesler (1956) investigated the nematofauna of the alfalfa rhizosphere. Deubert (1958) examined the soil in an alfalfa crop and obtained an approximate picture of the quantitative occurrence of the species found. The above exhausts the list of studies concerned with alfalfa crops from the faunistic aspect.

Investigations of the nematofauna of cultivated plants in Poland referred to potato, wheat, red clover, sugar beet, rape, barley and rye crops (Witkowska 1958, Witkowski 1958, 1962, Domurat and Sandner 1960). Nematodes in plants were investigated in the case of rye crops, and in the case of the remaining crops, only those in the soil. It will therefore be seen from the above that the nematofauna of alfalfa crops in Poland has not so far been examined, neither is mention of any kind made of the occurrence of pest species of nematodes on alfalfa crops in Poland.

The aim of this study was to: 1) ascertain the full species composition of nematodes occurring in two alfalfa crops: one younger and one older, which would also supply information on the variety of ecology forms of these nematodes and 2) compare the intensity of occurrence of each species in the upper parts of the plants, the roots and soil, which is equivalent to estimating the penetration of species from the soil to plants.

Some fragmentary results of studies on nematodes of alfalfa crops analysed

in this paper have been presented in separate publications. This applies to the one-year investigations of the seasonal dynamics of nematodes (Roguska-Wasilewska 1963), partial presentation of the species composition (Wasilewska 1964b) and descriptions of new species (Kozłowska and Roguska-Wasilewska 1963, Wasilewska 1964a, 1965a, 1965b, 1965c).

II. STUDY AREA

Investigations were made on two alfalfa fields situated to the north of Warsaw in the Nowy Dwór district. One of these fields (station *A*), 0.30 ha in area, was situated on the lower Vistula terrace between the dyke and river, near the village of Dziekanów Polski. When the level of the water in the river rose this area was flooded and the fields were fertilized in this way. Type of soil: brown illuvial soil, sandy, with pH 7.6 and the following soil profile:

A_1 (0–25 cm) – clayey sand, strong, greyish-brown, little humus with a few roots, compact in structure, crumbling into small clots when compressed, clearly transition to

B (25–55 cm) – clayey sand, greyish-sepia, interlayered with loose light yellow sand (8–10 cm), with lightly marked brown spots, sharp transition to

C (55–80 cm) – clayey sand, greyish-brown with thin layers (1 cm) of loose sand.

This field was sown with alfalfa mixed with oats in the spring of 1960. The previous year it had lain fallow. It adjoined a pasture, a three-year old alfalfa crop, an artificial and a natural meadow. The first year the amount of weeds was small, but became fairly considerable in the following years. During the study period the crop was not subjected to any agrotechnical operations. The long period of high water level affected the development of the plants unfavourably, resulting in low growth of green mass and roots. During the season the alfalfa was mown twice.

The second alfalfa field (station *B*) was 0.15 ha in area, and was situated in the village of Dziekanów Leśny. It lay on the upper Vistula terrace. Type of soil: brown soil with pH of 7.0 and the following profile:

A_1 (0–30 cm) – clayey sand, strong, greyish-brown, in gradual transition in the form of infiltrations into

B (30–60 cm) – clayey sand, brownish-yellow and into

C (60–80 cm) – coarse-grained sand, brownish-yellow, compact.

The field was sown with alfalfa only in the spring of 1958. The previous crop there had been potatoes. It adjoined a potato field, a one-year old alfalfa crop as monoculture and was bordered by the highway. The degree of invasion by weeds was slight. Mineral fertilization had been applied before sowing the alfalfa. The level of ground water on this station was far below that on

station *A*. Aeration of the soil was good due to the clot-like structure of the soil. The plants appeared healthy and produced considerable yields of green mass, making it possible to mow the field four times during the season.

III. METHODS

The problem of the size of plant or soil samples in nematological investigations has not yet been solved. An exception to this is formed by investigations of the cyst-forming nematodes (species of the genus *Heterodera*).

In analyses made to estimate the abundance of nematodes, or the intensity of occurrence of defined, chiefly pest species, of nematodes, large samples are taken, often as much as 200 ml of soil, and in analyses of the number of *Heterodera* cysts, even 1,000 ml of soil. If, however, the investigations are aimed at a detailed analysis of a larger number of species, the size of samples intended for extraction must of necessity be considerably smaller. The representative character of the sample is maintained in this case by taking many large samples in the area and then selecting from them, after mixing, a relatively small sample for extraction. This applies both to sampling from plant material and from the soil. Many of the authors whose investigations were concerned with the qualitative and quantitative state of the nematofauna of crops used samples of different sizes. Tulaganov (1949) in his qualitative and quantitative studies of nematofauna in 13 crops, accepted 2 plants as a plant sample, and 25 ml as a soil sample, which he took from a field sample 1,000 ml in volume. Oostenbrink (1954) when examining the significance and migrations of species of the genus *Pratylenchus*, took 10 g of root and 200 ml of soil. Karimova (1957) in her analyses of the occurrence of nematodes in the soil and in plants took 10 g plant samples and soil samples of 25 ml volume, with field samples of 200 ml in volume. Witkowska (1958) took 9.5 ml of soil once or twice a month in order to grasp the qualitative and quantitative differences between soil nematodes of different crops. Prasse (1959) in his quantitative studies of nematodes occurring in different cultivated soils, took 5 samples with a semi-cylindrical corer from a field, and from them 25 g for extraction. Cichorius (1960) took 50 ml soil samples in order to determine the seasonal dynamics and qualitative composition of parasitic nematode fauna of several crops. Coomans (1961) in his faunistic and ecological investigations of free-living nematodes of meadows, took soil samples 100 ml in volume, but samples of only 10 ml in volume for analysis made for identification purposes. Witkowski (1962), in examining the seasonal differences in the distribution of nematode species under a barley crop, took soil samples 6.36 ml in volume from 10 selected micro-stations. Winslow (1964) investigated variations in abundance of nematodes in the soil of different crops. He took samples from each field once a month, consisting of

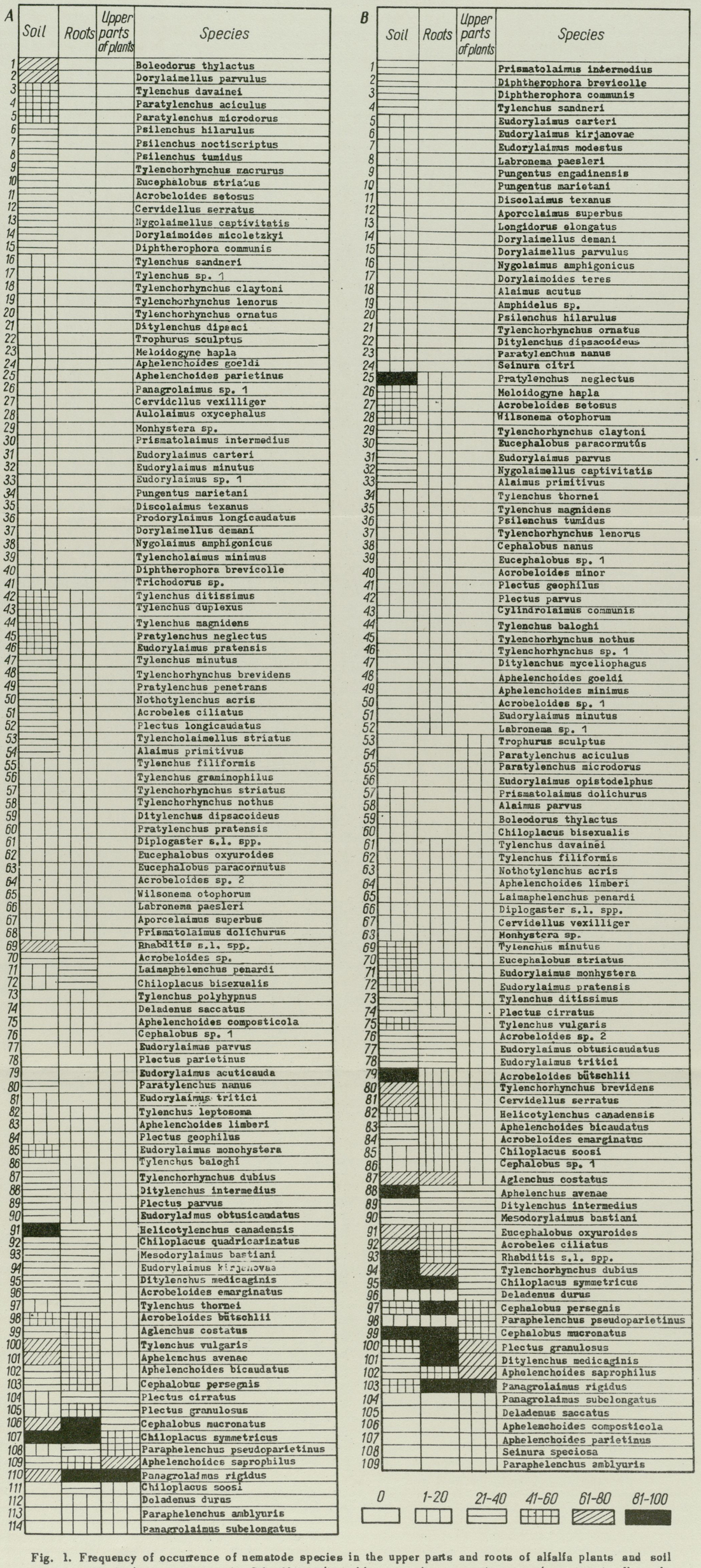

Fig. 1. Frequency of occurrence of nematode species in the upper parts and roots of alfalfa plants and soil
A — crop on station *A*, *B* — crop on station *B*. *0–100* — stations of frequency of occurrence in percent (occurrence in all samples in a given habitat was taken as 100%)

10–12 corer contents, and from this took 25 ml of soil for qualitative and quantitative analysis (in the case of some fields – 50 ml). The size of the sample therefore depends to a great extent on the purpose of the investigations.

Plant and soil samples were taken from the field on the two separate stations, at intervals of one month from July 1960 to July 1961, then, after an interval of nine months, from May 1962 to May 1963. Samples were thus taken for a total of 26 months[1]. The pattern of the two study periods on stations *A* and *B*, indicating the year of the alfalfa crop, was as follows:

Year of crop	1	3	5
Station *A*	1960–1961	1962–1963	
	1st study period	2nd study period	
Station *B*		1960–1961	1962–1963
		1st study period	2nd study period

Ten alfalfa plants were chosen at random and dug up on each of the stations once a month. One portion of soil was taken from the crop by means of a semi-cylindrical corer from the immediate vicinity of each of these plants. The sampling tool was a semi-cylindrical corer with a side slit, 1.5 cm in diameter and 25 cm high, thus giving a volume of 44.16 ml.

After rinsing the plants chosen for analysis the upper parts were separated from the roots and chopped into 0.5 cm sections (the thick roots were chopped into small pieces). After mixing thoroughly 4 portions were taken for extraction from the upper parts, each weighing 5 g and 4 portions from the roots, also weighing 5 g each. After mixing the soil from 10 corers 20 ml were taken for extraction.

Extraction of nematodes was carried out by means of the modified Baermann method (Oostenbrink 1960, Szczygieł 1963). This method gives good results when applied to small samples and about 80% of all nematodes are then obtained by it (Szczygieł 1963). No method has yet been found which obtains the whole of the nematodes. The diameter of the sieves used in this work was 9 cm, which permitted of spreading a thin layer of the plant and soil materials examined out over its surface. The material was kept on sieves for 3 × 24-hour periods, which proved to be sufficient. Data on the size and number of samples taken over the course of one month and over the whole study period for one of the stations are set out in Table I. The factual material presented jointly for the two stations is based on an analysis of 500 plants, from which 200 samples (1 kg) were taken from the upper parts of plants and 200 samples (1 kg) from the roots, and 22 litres of soils taken from the area, 1,000 ml of which were analysed.

Identification of species was made in the most numerous sample out of four samples from the upper parts of the plants, and in the most numerous

[1] On station *A* for 24 months, since no samples were taken in July 1960 and April 1962 as the Vistula flooded the area.

Collection method and number of field samples and samples taken from them for analysis of species in alfalfa crop on station *B**

Tab. I

	1 month					Whole study period (26 months)				
	number of plants chosen at random	number of samples (5 g) for abundance	total weight of samples for abundance (in g)	number of samples for analysis of species	weight of samples for species analysis (in g)	number of plants chosen at random	number of samples (5g) for abundance	total weight of samples for abundance (in g)	number of samples for analysis of species	weight of samples for species analysis (in g)
Upper parts of alfalfa plants	10	4	20	1	5	260	104	520	26	130
Alfalfa roots	10	4	20	1	5	260	104	520	26	130
Soil	number of corings taken with sampling tool	total volume of soil sampled (in ml)		volume of soil taken for species analysis (in ml)		number of corings taken with sampling tool	total volume of soil sampled (in ml)		volume of soil taken for species analysis (in ml)	
	10	440		20		260	11.440		520	

*Samples were taken for 24 months on station *A*.

root sample also, as for the 20 ml soil samples. Table II gives the numbers of identified nematodes obtained from the upper parts of alfalfa plants, roots, soil and weeds in the crops examined. Permanent glycerine preparations were made from all the individuals by means of the slow dehydration method (Thorne 1961). F.A.A. was used as fixative. The preparations are kept in the collections of the Nematological Laboratory of the Institute of Ecology, Polish Academy of Sciences.

Number of nematodes extracted from samples taken for species analysis

Tab. II

	Station *A*	Station *B*	
Number of nematodes in upper parts of alfalfa plants	1.538	3.114	
Number of nematodes in alfalfa roots	1.854	3.476	
Number of nematodes in soil	3.649	3.136	
Number of nematodes in upper parts of weeds	40	772	
Number of nematodes in roots of weeds	44	122	
Total	7.125	10.620	= 17.745

In order to ascertain to what degree the 5 g sample represents the species composition of nematofauna, comparison was made of abundance, number of species and percentage of the most numerous species in four analogical 5 g samples (from one month) taken from the upper parts of plants, and correspondingly from four root samples (Tab. III and IV). Differences were greater on station *A* (younger alfalfa) than on station *B* (older alfalfa). On station *A* the sample with the greatest abundance was four times greater than the sample with the smallest abundance in the upper parts of plants and slightly less than three times greater in the roots (Tab. III). The analogical relation on station *B* was more or less 2:1 (Tab. IV). The number of species common to four samples formed one third of the species found in the most numerous sample from the upper parts of plants, and half of the species found in the most numerous sample from the roots on both stations. It is also a characteristic fact that the most numerous species occurred in all the samples (treated as

Comparison of abundance of nematodes, number of species and percentage of the most numerous species of nematodes in 4 analogical samples from May 1963 in crop on station 4

Tab. III

Upper parts of alfalfa plants					Alfalfa roots				
Repeats	1	2	3	4	Repeats	1	2	3	4
Abundance of nematodes in sample (5 g)	69	65	23	16	Numbers of nematodes in sample (5 g)	135	129	73	54
Number of species in sample	9+*R*	3	3	3+*R*	Number of species in sample	25+*R*	18+*R*	18+*R*	14+*R*
Number of species common to all 4 samples	3				Number of species common to all 4 samples	7+*R*			
Percentage of most numerous species:					Percentage of most numerous species:				
1. *Panagrolaimus rigidus*	63	92	86	62	1. *Panagrolaimus rigidus*	49	38	52	35
2. *Aphelenchoides saprophilus*	17	5	4	25	2. *Cephalobus mucronatus*	10	10	6	15
					3. *Chiloplacus symmetricus*	2	6	4	1
					4. *Aphelenchoides bicaudatus*	6	2	3	5

R = *Rhabditis* s. l.

Comparison of abundance, number of species and percentage of the most numerous species of nematodes in 4 analogical samples from May 1963 in crop on station *B*

Tab. IV

Upper parts of alfalfa plants					Alfalfa roots				
Repeats	1	2	3	4	Repeats	1	2	3	4
Abundance of nematodes in sample (5 g)	19	18	11	10	Numbers of nematodes in sample (5 g)	171	162	142	96
Number of species in sample	8	12	9+*R*	8	Number of species in sample	29+*R*	27+*R*	25	21
Number of species common to all 4 samples	5				Number of species common to all 4 samples	15			
Percentage of most numerous species:					Percentage of most numerous species:				
1. *Panagrolaimus rigidus*	21	11	18	30	1. *Panagrolaimus rigidus*	28	11	10	11
2. *Ditylenchus medicaginis*	10	6	9	10	2. *Cephalobus persegnis*	10	24	23	22
3. *Plectus granulosus*	31	11	9	10	3. *Cephalobus mucronatus*	8	17	13	8
4. *Cephalobus mucronatus*	10	6	9	10	4. *Ditylenchus medicaginis*	6	3	2	15
					5. *Plectus granulosus*	8	5	7	4
					6. *Tylenchorhynchus dubius*	1	1	2	6

R = *Rhabditis* s. l.

repeats) from roots and the upper parts of plants. The percentage of these species varied fairly considerably within the repeats, nevertheless the domination proportion between them was maintained. This forms evidence of the relatively even occurrence of numerous species of nematodes in plants. For these reasons the qualitative-quantitative analyses of nematodes in plants based on one, but the most numerous, sample (5 g) would appear sufficient to establish the quantitative proportions between species and groups of species. It must be added that these relations were defined on the basis of 13 samples taken over the period of each of the two study periods, and in the case of frequency of occurrence of species, on the basis of 26 samples taken jointly.

The abundance of nematodes in soil samples (20 ml in volume) from one month, obtained from the mixture of the contents of 10 corers, did not differ greatly. Table V illustrates the abundance of nematodes in four analogical repeats from May 1961.

Numbers of nematodes in four analogical soil samples (each 20 ml in volume) from May 1961

Tab. V

	Station *A*				Station *B*			
Repeats	1	2	3	4	1	2	3	4
Numbers of nematodes	73	95	83	91	334	320	295	340

Analysis of weeds for the presence of nematodes was also made during the initial period of the investigations. About 10 species of the commonest weeds were taken from both stations. The plants of each species were taken and extracted for nematodes in the same way as the alfalfa plants.

IV. DESCRIPTION OF THE SPECIES OF NEMATODES FOUND

The species of nematodes found in two alfalfa crops are described below, in plants, soil and weeds. They will be discussed in systematic order (Goodey 1963). Data in distribution of species of nematodes were taken chiefly from the following nematological studies: Thorne 1957, 1961, Thorne and Swanger 1957, Christie 1959, Meyl 1960, Decker 1962, Goodey 1963, Paramonov 1962, 1964, Goodey and Franklin 1956, Goodey, Franklin and Hooper 1959. No reference is made in these cases to literature, but only the most recent studies are cited which are not taken into consideration in the above papers. In regard to the occurrence of nematodes in Poland reference has been made chiefly to literature relating to definite agricultural

crops. During the study period a total of 137 species, belonging to 34 genera, from 22 families, were found to occur. At the end of the description of each species its appurtenance is given to an ecological group, according to Paramonov's classification (1952, 1962, 1964) using the following abbreviations: *P* – pararhizobionts, *E* – eusaprobionts, *H* – hemisaprobionts, *FP* – facultative parasites and *OP* – obligatory parasites. The next study will be devoted to a more comprehensive analysis of the ecological groups distinguished.

Species:

1. *Aglenchus costatus* (de Man 1921) Meyl 1960. Species of the genera *Aglenchus*, *Tylenchus* and *Psilenchus* occur in the rhizosphere of plants; they probably feed on the roothairs or on fungal hyphae, but food habits largely unknown.

A. costatus is known from Europe and America, and is probably a cosmopolitan species. The fact of its having been found by Cobb (after Thorne 1961) in the roots of *Paeonia officinalis*, on which it caused gall-like swellings, must be recorded. This is the only report of the genuinely harmful properties of this species. It has not so far been noted on alfalfa crops.

Found in the upper parts and roots of alfalfa, and in the soil, on both stations and in fairly considerable numbers. This is the first report of the occurrence of this species in Poland. Apart from numerous females one male was also found, unknown in the case of this species; a description of the male is given in a separate publication (Wasilewska 1964a). *FP–OP?*

2. *Tylenchus baloghi* Andrássy 1958. Found by the author of the species in soil in Bulgaria, and not so far recorded again. New to alfalfa crops and the fauna of Poland.

It occurred sporadically in the upper parts and roots of alfalfa in the crops examined, and also abundantly in the soil on station *A*, and in the roots of alfalfa on station *B*. In addition to several females, males unknown for this species were found (Wasilewska 1965b). *FP?*

3. *Tylenchus davainei* (Bastian 1865) Filipjev 1934. The geographical spread of this species is wide, it is known from Europe, the United States of America and Venezuela. It occurrs chiefly in the soil, but has been given by Usmanova (1962) from the upper parts and roots of strawberry plants, and treated by her as a typical plant pest. It was recorded by Karimova (1957) as occurring in soil under alfalfa. In Poland it was found in several places, including the soil under a potato crop (Witkowski 1958), under red clover and winter rape (Witkowska 1958) and in the tissues of rye (Donurat and Sandner 1960).

In the case of the crops examined it occurred in the soil on station *A* and in plants and soil on station *B*. *FP?*

4. *Tylenchus ditissimus* Brzeski 1963. Brzeski (1963b) found this species in peat mosses in the Tatra Mountains and in forest soil near Skierniewice.

The finding of this species in an alfalfa crop, that is, under cultivated plants, in fairly considerable numbers leads to the assumption that its occurrence is ubiquitous. This is the first report, after that made by the author of the species, of the occurrence of *T. ditissimus*.

It occurred in alfalfa roots and soil on station *A* and in alfalfa plants and soil on station *B*. *FP?*

5. *Tylenchus duplexus* (Hagemeyer, Allen 1952) Andrássy 1954. Described and found in California in garden soil under grass. New to the fauna of Europe, and also not previously recorded in alfalfa crops.

Fairly numerous individuals originate from the soil and single ones from alfalfa roots on station *A*. *FP?*

6. *Tylenchus filiformis* Bütschli 1873. A cosmopolitan ubiquitous species occurring in soil, on mosses, in fresh-water and in different crops, but it is probable that reports of its occurrence refer to more than one species. It has been recorded as occurring in alfalfa crops, in the roots and soil, by Tulaganov (1949), Belaeva (1951) and Karimova (1957); in alfalfa roots by Paesler (1956) and in soil by Deubert (1958). It has been noted several times in Poland, both in bodies of water, mosses and soils. It was reported by Witkowski (1958) from the soils of potato, spring and winter wheat crops, by Witkowska (1958) from the soil of potato crops, and also winter wheat, red clover, beet sugar and winter rape, and by Domurat and Sandner (1960) from rye plants. It is probably that not all identifications are unambiguous and at least part of them refer to species of the genus *Tylenchus* which have not as yet been described.

Single individuals were found in the roots of alfalfa and soil on station *A* and in plants and soil on station *B*. *FP?*

7. *Tylenchus graminophilus* (Siddiqi 1959) Goodey 1963. Siddiqi (1959) assumes that *T. graminophilus* is an ectoparasite of plant roots, and possible feeds on hyphae of fungi in the rhizosphere. Investigation of the parasitic (or pathogenic) properties will probably make the degree of harmfulness of this species clear in the future. Siddiqi found it round the roots of grasses and states that it is widespread in Northern India. In Europe, and thus also in Poland, it has not so far been recorded either from alfalfa crops up to the present.

Several individuals were found, chiefly in soil and alfalfa roots on station *A*. *FP?*

8. *Tylenchus leptosoma* (de Man 1880) Andrássy 1954. A cosmopolitan species, known in Europe and the United States of America and also Venezuela. Recorded by Tulaganov (1949) in plants and by Karimova (1957) in soil under alfalfa crops. Given as occurring in moss in Poland (Brzeski 1962b) and in soil under potato crops, spring and winter wheat (Witkowski 1958), and red clover, sugar beet and winter rape (Witkowska 1958).

It occurred in small numbers in plants and soil on station *A*. *FP?*

9. *Tylenchus magnidens* (Thorne 1949) Goodey 1963. The author described this species on the basis of individuals (females) found in soil under an alfalfa crop in the state of Utah (USA). Data on its occurrence in Europe are known from Holland only (Loof 1961, Loof and Oostenbrink 1961), but it would seem that this is a fairly widespread species. It has not as yet been recorded in Poland.

It occurred sporadically in alfalfa roots and relatively numerously in the soil on station *A*, and less numerously in roots and in soil on station *B*. A male unknown for this species was found and described (Wasilewska 1964a). *FP?*

10. *Tylenchus minutus* Cobb 1893 (Andrássy 1954). Hitherto known only from Australia, Hungary and Germany. It has not so far been recorded on alfalfa crops or in Poland.

It occurred in alfalfa roots and frequently in soil on station *A*, and in plants and also more often in soil on station *B*. One individual was also found in the roots of *Polygonum convolvulus* L., a weed on station *B*. *FP?*

11. *Tylenchus polyhypnus* (Steiner, Albin 1946) Andrássy 1954. Known from North America, Germany and Hungary, defined as rare. Hitherto unknown from alfalfa crops and from Poland.

One individual was found in alfalfa roots on station *A*. *FP?*

12. *Tylenchus sandneri* Wasilewska 1965. New species, described (Wasilewska 1965a) on the basis of females and males found in small numbers in soil on both stations. *FP?*

13. *Tylenchus thornei* Andrássy 1954. Found by Andrássy in humus soil and soil round roots of grasses in Hungary and in grassland soils in Belgium, also given from Germany. New to alfalfa crops and to the fauna of Poland.

It occurred in plants and soil on station *A* and in alfalfa roots and in soil on station *B*. *FP?*

14. *Tylenchus vulgaris* Brzeski 1963. In connection with the ambiguous concept of *Tylenchus filiformis* Bütschli (1873) – Brzeski (1963a) considered *Tylenchus filiformis* Bütschli sensu Andrássy 1954 as a new species, and gave it the name *T. vulgaris*. This author found individuals of *T. vulgaris* in several places in Poland in the soil round plant roots; he also stated that he found it in soils under crops in Eastern Germany. It is probably a widespread species. It has not been reported from alfalfa crops as *T. vulgaris* , but it is not out of the question that some of the identifications of *T. filiformis* Bütschli refer to this species.

It occurred fairly numerously in plants and soil on both stations. *FP?*

15. *Tylenchus* sp. 1. Two individuals belonging to a species not hitherto described were found in soil on station *A*. Dimensions of 1 female: length 0.35 mm, a–39; b–5; c–5; V–63; dimensions of 1 male: length 0.32 mm, a–45; b–4.5; c–5. The individuals found possessed: spear 8.4 μ long, with well

formed knobs, distinct cuticular annulation, with width of striae 1.7 μ in the centre of the body and 2.4 μ on the tail, lateral fields occupying 1/3 of width of body, external lines of lateral field distinctly angulate, while the internal lines, probably two, run very close to each other giving the impression of one line, spermatheca oval, post-uterine sac shorter than 1/2 body width in the region of the vulva. The spicula in the male is 9 μ long, gubernaculum small. Tail narrows slightly towards end, rounded at tip, similar in both sexes. *FP*?

16. *Psilenchus hilarulus* de Man 1921. Noted from the soil round roots of many plants in Holland, Belgium, Germany and the United States of America, and also Venezuela. The feeding habits of species of the genus *Psilenchus* is in principle unknown, they probably feed on plant juices and do not penetrate into the plants. Known from alfalfa crops in the United States. Not so far recorded in Poland.

It occurred in the soil on both stations. *FP*?

17. *Psilenchus noctiscriptus* Andrássy 1962. Andrássy (1962a) found this species in Hungary on grass roots. It has not been found again. New to alfalfa crops and fauna of Poland.

It occurred in the soil on station *A*. *FP*?

18. *Psilenchus tumidus* Colbran 1960. Found in soil in Australia. New to the fauna of Europe and to alfalfa crops.

Single individuals occurred in the soil on station *A* and in alfalfa roots and soil on station *B*. *FP*?

19. *Tylenchorhynchus brevidens* Allen 1955. Species of the genus *Tylenchorhynchus* are ecto- and partly endo-parasites of plant roots. Many of them have been proved to have pathogenic properties, which consist in inhibiting the growth of plants, deforming roots and their necrosis.

T. brevidens is known so far from Holland and the United States of America. It is probably a cosmopolitan species. As shown by the investigations made by Langdon, Struble and Young (1961), this species is a typical parasite of wheat and barley, since by parasitizing the roots it causes yellowiness and dwarfing of the plants and inhibits growth. It is known from alfalfa crops in the United States. In Poland there has only been one mention of its occurrence so far, in park soil (Brzeski 1963c).

It occurred in alfalfa roots and soil on station *A* and in larger numbers in plants and soil on station *B*. *OP*.

20. *Tylenchorhynchus claytoni* Steiner 1937. A widespread species in all parts of the world, a serious pest of many plants, chiefly tobacco. Krusberg's investigations (1959) show that populations of *T. claytoni* can also develop well on alfalfa. Noted in the United States of America on alfalfa crops. There is one mention of its occurrence in park soil in Poland (Brzeski 1963c).

Single individuals occurred in the soil on station *A* and it was more frequently encountered in the soil and alfalfa roots on station *B*. *OP*.

21. *Tylenchorhynchus dubius* (Bütschli 1873) Filipjev 1936. A widespread and cosmopolitan species, considered as a typical parasite. Scarbilovič (1962a, 1962b) emphasises its parasitic properties in relation to many cultivated plants. Klinkenberg (1963) examined the feeding habits of this species, and ascertained that it chiefly attacks the gemmae of the roots, thus causing weakening of the growth rate of the upper parts of the plant. *T. dubius* was recorded in alfalfa crops: in roots and soil by Tulaganov (1949), in soil by Belaeva (1951), in the rhizosphere of plants by Paesler (1956) and in soil by Deubert (1958). It has been noted in Poland several times, including occurrence in cultivated soils (Witkowska 1958, Witkowski 1958, 1962) and in rye (Domurat and Sandner 1960).

It occurred in plants and soil on both stations, and also in the upper parts of *Melandrium noctiflorum* (L.) Fr., a weed on station *B*. *OP*.

22. *Tylenchorhynchus lenorus* Brown 1956. There has so far been a lack of data on the wider occurrence and possible pathogenic significance of this species. Individuals of *T. lenorus* are mentioned as occurring in the rhizosphere of strawberries and roots of oats (Loof 1959). It has not so far been reported from alfalfa crops or in Poland.

It occurred in small numbers in the soil on station *A* and in alfalfa roots and soil on station *B*. *OP*?

23. *Tylenchorhynchus macrurus* (T. Goodey 1932) Filipjev 1936. A species common throughout Europe. The species has been observed to penetrate to the roots but it has not as yet been established whether it is pathogenic. It was reported from the soil near alfalfa roots by Tulaganov (1949). In Poland it has been reported in soil under spring and winter wheat crops, potatoes and sugar beet (Witkowska 1958, Witkowski 1958).

It occurred in the soil on station *A* and in the roots of a weed on this station, *Glechoma hederacea* L. *OP*?

24. *Tylenchorhynchus nothus* Allen 1955. Known from Holland from the soil round grass roots. Not so far reported from alfalfa crops or from Poland.

It occurred sporadically in alfalfa roots and the soil on station *A* and in the roots of *Avena sativa* L., a weed on this station, and also singly in alfalfa roots on station *B*. *OP*?

25. *Tylenchorhynchus ornatus* Allen 1955. Known from Holland, Belgium and the United States of America. The pathogenic properties of this species have not so far been proved. New to alfalfa crops and the fauna of Poland.

It occurred singly in the soil on both stations. *OP*?

26. *Tylenchorhynchus striatus* Allen 1955. Hitherto known only from Holland and the United States of America. New to alfalfa crops and the fauna of Poland.

It occured singly in alfalfa roots and the soil on station *A*. *OP*?

27. *Tylenchorhynchus* sp. 1. Several immature individuals, belonging to a spe-

cies, not so far described, of the genus *Tylenchorhynchus*, were found in alfalfa roots on station *B*. They come from the group of species of the genus *Tylenchorhynchus* which is distinguished by having head not offset, a rounded and striated tail and four lines in the lateral field. *OP*?

28. *Trophurus sculptus* Loof 1956. Known from Holland and the United States of America. Feeding habits not so far known. Found in Holland in alfalfa crops. Not so far reported from Poland.

It occurred singly in the soil on station *A* and in the upper parts of alfalfa plants on station *B*. *OP*?

29. *Ditylenchus dipsaci* (Kühn 1857) Filipjev 1936. An obligatory plant parasite, chiefly on green parts, rare in soil. Known from both hemispherees of the world. Known from alfalfa crops in Germany, Holland, Czechoslovakia, Sweden, Soviet Union, South Africa, United States of America (California, Utah, Colorado, Oklahoma, Oregon), Brazil and the Argentine. It causes great damage to alfalfa crops (Brown 1957). Found in Poland in cultivated soils (Witkowski 1958, Witkowska 1958) and rye (Domurat and Sandner 1960). It is however known that it occurs throughout Poland. Lack of elaborations of the distribution and harmfulness of this species in Poland.

Only three individuals of this species were found in the soil on station *A*. *OP*.

30. *Ditylenchus dipsacoideus* (Andrássy 1952) Andrássy 1956. Since its being found by the author of the species it has not again been reported as occurring. Andrássy emphasises that this species is not an obligatory plant pest. New to alfalfa crops and Poland.

It occurred rarely in alfalfa roots and soil on station *A* and in soil on station *B*. *FP*.

31. *Ditylenchus intermedius* (de Man 1880) Filipjev 1936. A widespread species, frequent in the soil near the roots of many plants. Equally frequently observed in plant tissues by many research workers, particularly Russian scientists. The pathogenicity of this species has not been confirmed. It was found in alfalfa crops: by Kirjanova (1935) in leaves and stems, by Tulaganov (1949) in roots, by Belaeva (1951) in roots and soil and by Paesler (1956) in the rhizosphere. Found in rye in Poland by Domurat and Sandner (1960).

It occurred fairly frequently in plants and soil on both stations. *FP*.

32. *Ditylenchus medicaginis* Wasilewska 1965. Description of this species (Wasilewska 1965c) was made on the basis of numerous individuals found in the upper parts and roots of alfalfa in the crops examined. It occurred sporadically in the soil. Individuals in all stages of development were observed in plants. Both these facts indicate that plant tissue is a suitable habitat for *D. medicaginis*. It is very probable that this species is an obligatory plant

parasite, but it did not prove possible to observe symptoms of plant disease under field conditions.

D. medicaginis occurred on both stations, but in greater quantities on the older alfalfa crop. *OP?*

33. *Ditylenchus myceliophagus* J.B. Goodey 1958. Known from Europe and India, chiefly as a mushroom parasite. Apart from its feeding on the hyphae of fungi no other feeding habits have been reported. New to alfalfa fauna and the fauna of Poland.

Single individuals were found in alfalfa roots on station *B*. *FP*.

34. *Meloidogyne hapla* Chitwood 1949. An obligatory plant parasite chiefly in tropical and subtropical regions, mainly found in glasshouse conditions in temperate zones. The role of this species in open ground under the climatic conditions of Poland has not been revealed despite the fact that its occurrence has been reported under these conditions in Holland, Belgium, England, the Soviet Union and Germany. According to Decker (1961) the significance of this species to our crops should be reconsidered. *M. hapla* is common on alfalfa roots in California. Sasser (1954) also defines alfalfa as a host plant of this species. Mc Guire, Walters and Slack (1958) demonstrated that the danger of disease caused by *Fusarium* increases in alfalfa crops invaded by *Meloidogyne* sp. The first data on the occurrence of this species in Poland referred to medicinal herbs (Bogucka 1960). It is now known that it is common in Poland.

Single larvae most probably belonging to *M. hapla* were found in the soil on station *A* and larvae were found in greater numbers in the soil and singly in roots on station *B*. No galls were observed. *OP*.

35. *Helicotylenchus canadensis* Waseem 1961. Species of the genus *Helicotylenchus* are migrant ectoparasites of plant roots and are suspected of being very harmful to plants.

H. canadensis was found for the first time in the rhizosphere of *Trifolium pratense* in Canada (Waseem 1961). Recently (Yuen 1964) its occurrence was reported in England. Not reported in alfalfa crops, and is also new to the fauna of Poland.

It occurred sporadically in the upper parts and often in the roots of plants, and in the soil on both stations. *OP?*

36. *Pratylenchus neglectus* (Rensch 1924) Chitwood, Oteifa 1952. Species of the genus *Pratylenchus* are migrating endoparasites of plants and exercise a considerable influence on plants as a result of their highly-developed enzymatic and toxic activity. They cause serious losses in crop yield. All stages of development, together with adult individuals, are capable of infecting plants. The reactions of attacked plants differ depending on the species of nematode, species of host plant and cultivation conditions.

P. neglectus is widespread in countries with temperate climates. It has

been reported up to the present from Holland, Denmark, Belgium, Germany, the Unitet States of America and Canada, but has not so far been reported from alfalfa crops. There is one report of this species' occurrence in park soil in Poland (Brzeski 1963c).

It occurred in roots and soil on both stations, but more abundantly in the older crop. It was also observed in the roots of *Polygonum convolvulus* L., a weed on station *B*. *OP*.

37. *Pratylenchus penetrans* (Cobb 1917) Chitwood, Oteifa 1952. A widespread (range of occurrence similar to that of *P. neglectus*), polyphagous pest of many cultivated plants, particularly in light soils. Reported from alfalfa crops in the United States (Jensen 1953). Reported once in Poland, together with *P. neglectus* (Brzeski 1963c).

It occurred fairly abundantly in alfalfa roots and the soil on station *A* and in the roots of a weed, *Glechoma hederacea* L. *OP*.

38. *Pratylenchus pratensis* (de Man 1880) Filipjev 1936. A parasite known in both hemispheres of the world to constitute a serious danger to cultivated plants. Reported in alfalfa crops: by Cobb (1922), Tulaganov (1941, 1949, 1950) in plants and soil, by Belaeva (1951) and Paesler (1956) in roots and by Karimova (1957) in roots and soil. It frequently occurs in alfalfa crops in the United States of America. Reported in Poland in the soils of several crops: potatoes, wheat, barley, red clover, sugar beet and winter rape (Witkowska 1958, Witkowski 1958, 1962).

It occurred in small numbers in alfalfa roots and the soil on station *A*. *OP*.

39. *Paratylenchus aciculus* Brown 1959. Species of the genus *Paratylenchus* are ectoparasites of plant roots. The pathogenic character of several of these species in relation to plants is well known. Symptoms of the damage done by them consist chiefly in limitation of the plants' growth.

P. aciculus was found and described in Canada. The first report on the occurrence of this species in Europe comes from Poland, where it occurred round strawberry roots (Brzeski and Szczygieł 1963). It has not as yet been established whether this species is pathogenic. Not so far reported from alfalfa crops.

It occurred in the soil on station *A* and once only in the upper parts of alfalfa plants on station *B*. *OP*?

40. *Paratylenchus microdorus* Andrássy 1959. The author of this species described it on the basis of individuals found in the rhizosphere of grasses in Yugoslavia. It is also known in Belgium and England. It has not been established that it is pathogenic. Not so far reported from alfalfa crops. In Poland reported by Brzeski and Szczygieł (1963) from several places.

It occurred in the crops examined similarly to *P. aciculus*. *OP*?

41. *Paratylenchus nanus* Cobb 1923. Known from Germany, the United States of America and probably Czechoslovakia. Pathogenicity not yet proved. New to

alfalfa crops. Brzeski and Szczygieł (1963) found it in Poland in the soil round roots of roses, grasses and in the soil on which potatoes had been grown.

It occurred chiefly in the soil and once in the upper parts of alfalfa on station *A* and in the soil on station *B*. *OP?*

42. *Deladenus durus* (Cobb 1922) Thorne 1941. Reported in the United States of America (inter alia from alfalfa crops), in Germany and Venezuela. According to Thorne (1961) the occurrence of this species is connected with decomposing plant material, in which the hyphae of fungi form its food. Not so far reported in Poland.

It occurred scantily in alfalfa plants on both stations and in the soil and weeds on station *B* in the upper parts of *Apera spica-venti* (L.) P.B. and in roots of *Artemisia vulgaris* L. *FP*.

43. *Deladenus saccatus* Andrássy 1954. Found in Hungary and not reported again. New to alfalfa crops and the fauna of Poland.

It was found twice in the crops examined, in the form of single individuals in roots on station *A* and the upper parts of alfalfa on station *B*. *FP?*

44. *Nothotylenchus acris* Thorne 1941. Known from the United States of America, Italy, Japan, Germany and Holland. Suspected of feeding on fungal hyphae. According to Nishizawa and Iyatomi (1955) it is a typical strawberry parasite. Only further investigations can reveal the significance of this species to plants. Noted from alfalfa crops from the United States of America (Thorne 1961) and Germany (Deubert 1958). Not so far known in Poland.

It occurred in small numbers in roots and the soil on station *A* and in roots and soil on station *B*. *OP?*

45. *Boleodorus thylactus* Thorne 1941. Given as common in the soil of alfalfa crops in the United States of America, also noted in Holland. Thorne (1961) assumes that this species feeds on roothairs and may therefore be of significance in agriculture. New to the fauna of Poland.

It occurred chiefly in the soil on both stations. *FP?*

46. *Aphelenchus avenae* Bastian 1865. A species known in both hemispheres of the world. It is a pantophage, since the food eaten by this species consists of hyphae of different species of fungi, other nematodes and plant (chiefly root) tissue. Decker (1962, 1963) considers that degree to which this facultative plant parasite is pathogenic is slight. Under conditions favourable to rapid reproduction, however, damage may occur on plants. Facts are also known of this species facilitating invasion of plants by fungi. In alfalfa crops, both in plants and soil, it has been reported several times (Kirjanova 1935, Tulaganov 1941, 1949, 1954a, 1954b, Belaeva 1951, Paesler 1956, and Karimova 1957). In Poland it was found in park soil (Brzeski 1963c), and cultivated soil (Witkowska 1958, Witkowski 1958, 1962).

It occurred in large numbers in alfalfa plants and the soil on both stations.

It was also observed in the upper parts of *Taraxacum officinale* Web. and *Rorippa silvestris* (L.) Bess., and the roots of *Avena sativa* L., *Achillea millefolium* L. and *Glechoma hederacea* L., weeds on station *A*, and in the roots of *Achillea millefolium* L., a weed on station *B*. *FP*.

47. *Aphelenchoides bicaudatus* (Imamura 1931), Fil., Sch. Stek. 1941. Known from Japan, Germany, the Soviet Union, India and Venezuela. Its way of life is in principle unknown. Paramonov (1962) includes it in the group of nematodes feeding on fungi hyphae (mycophages). Not so far reported from alfalfa crops. Reported in Poland from soil under potatoes winter and spring wheat (Witkowski 1958) and rye (Domurat and Sandner 196).

It occurred in plants and soil on both stations and in the roots of the following weeds on station *B* – *Artemisia vulgaris* L. and *Apera spica-venti* (L.) P.B. *FP*?

48. *Aphelenchoides composticola* Franklin 1957. The chief representative of the nematode fauna of mushrooms, feeding on fungus hyphae. Often encountered in compost soil. There are no data on whether this is the only food of this species. Not so far reported from alfalfa crops and in Poland.

Single individuals were found in the upper parts of alfalfa plants on station *B* and in alfalfa roots on station *A*. It also occurred in the roots of the weed *Glechoma hederacea* L. on station *A* and in those of the weeds *Polygonum convolvulus* L. and *Achillea millefolium* L. on station *B*. *FP*.

49. *Aphelenchoides goeldi* (Steiner 1914) Fil., Sch. Stek. 1941. Described from Switzerland as a soil form. Feeding habits unknown. Not so far reported in alfalfa crops and in Poland.

It occurred sporadically in the soil on station *A* and roots of alfalfa on station *B*. *FP*?

50. *Aphelenchoides limberi* Steiner 1936. A species reported in the soil in Holland, Germany, England and the Soviet Union. It was also found in iris bulbs. According to Hooper's observations (1962) it feed on fungus hyphae under experimental conditions. Not so far reported from alfalfa crops. Reported in Poland in the soil under of potato, spring and winter wheat crops (Witkowski 1958).

It occurred in small numbers in plants and soil on both stations. *FP*.

51. *Aphelenchoides minimus* Meyl 1953. The author of the species found it in fumarola soil in Italy, not found a second time. New to alfalfa crops and fauna of Poland.

It occurred in one of the root samples on station *B*. *FP*?

52. *Aphelenchoides parietinus* (Bastian 1865) Steiner 1932. After the redescription of this species by Franklin (1955) it is now known that the numerous reports of its occurrence were not without ambiguity and probably referred to species of similar morphological structure, hence different views have been held as to the significance of *A. parietinus* to plants. It has fre-

quently been reported on alfalfa crops by Kirjanova (1935), Tulaganov (1949, 1950, 1954b), Belaeva (1951), Paesler (1956), Karimova (1957) and Deubert (1958) both in plants and soil. In Poland it was found in mosses, periphyton and soils. It was reported from cultivated soils by Witkowska (1958), Witkowski (1958, 1962) and from rye by Domurat and Sandner (1960).

Single individuals of *A. parietinus* sensu Bastian 1865 were observed in the crops examined in soil on station *A* and in the upper parts of alfalfa on station *B*. *FP?*

53. *Aphelenchoides saprophilus* Franklin 1957. Probably a widespread species, so far observed in soil. Franklin demonstrated that it feeds on hyphae of fungi under experimental conditions. There are no data on the settlement and connection of this species with plants. It was not observed as *A. saprophilus* in alfalfa crops, but is it very probable that some of the identifications refferring to *A. parietinus* included *A. saprophilus*. In Poland it has been reported up to the present only by Brzeski (1963c) in park soil.

It occurred numerously in plants and soil on both stations. In addition it was found in *Taraxacum officinale* Web. and *Glechoma hederacea* L., weeds on station *A*, and *Artemisia vulgaris* L., *Apera spica-venti* (L.) P.B., *Polygonum convolvulus* L., *Bromus mollis* L., *Stellaria media* Vill. and *Achillea millefolium* L., weeds on station *B*. *FP?*

54. *Seinura speciosus* (Andrássy 1958) J.B. Goodey 1960. Found by Andrássy in soil with decomposing pine bark in Bulgaria and not reported again. Feeding habits unknown. New to alfalfa crops and the fauna of Poland.

One male found in the upper parts of alfalfa on station *B*. *FP?*

55. *Seinura citri* (Andrássy 1957) J.B. Goodey 1960. Found by the author of the species on roots of young citrus trees from Hungary. Not again reported. New to alfalfa crops and the fauna of Poland.

One female found in the soil on station *B*. *FP?*

56. *Laimaphelenchus penardi* (Steiner 1914) Fil., Sch. Stek. 1941. Known from Switzerland, the Soviet Union und the United States of America. No full data available on the feeding habits of this species. It is true that *L. penardi* was observed to feed on the larvae of *Parasitorhabditis obtusa* (after Thorne 1961) but this does not rule out the possibility of other feeding habits. Not hitherto observed in alfalfa crops and in Poland.

It occurred in the roots of alfalfa plants and the soil on station *A* and in plants and soil on station *B*. *FP?*

57. *Paraphelenchus amblyuris* Steiner 1934. The author of the species isolated individuals from the diseased tissues of *Dioscorea batatas* from Japan and on this basis considered *P. amblyuris* to be a parasitic species. Also reported from the Soviet Union. New to alfalfa crops and the fauna of Poland.

It occurred in small numbers in alfalfa on station *A* and once only in the upper parts of alfalfa on station *B*. *FP*?

58. *Paraphelenchus pseudoparietinus* (Micoletzky 1922) Micoletzky 1925. A widespread species throughout Europe, encountered both in soil round roots and in plant tissues. Considered as a facultative parasite. Reported from alfalfa crops by Tulaganov (1949, 1950, 1954b) from soil and roots of plants. Observed in Poland in the soil of red clover and beet sugar crops (Witkowska 1958), potatoes, spring and winter wheat, and barley (Witkowski 1958, 1962) and in rye tissues (Domurat and Sandner 1960).

It occurred numerously in plants and soil on both stations, and in the following weeds on station *A*: *Rorippa silvestris* (L.) Bess. and *Glechoma hederacea* L. and on station *B*: *Chenopodium album* L., *Melandrium noctiflorum* (L.), Fr., *Erigeron canadensis* L., *Polygonum aviculare* L., *Artemisia vulgaris* L., *Apera spica-venti* (L.) P.B., *Polygonum convolvulus* L., *Bromus mollis* L., *Stellaria media* Vill. and *Achillea millefolium* L. *FP*.

59. *Diplogasteritus nudicapitatus* (Steiner 1914) Paramonov 1952. Species of the genera *Diplogaster* s. l. and *Rhabditis* s. l. are considered as saprobionts. They occur in habitats forming medium for the development of micro-organisms, such as soil (particularly compost soil) and decaying plant tissues.

D. nudicapitatus is a species known from Europe. It has not hitherto been reported from alfalfa crops. Found in manure in Poland (Janik 1962).

Several individuals were found in alfalfa roots on station *A*. *E*.

60. *Pristionchus lheritieri* (Maupas 1919) Paramonov 1952. A species known from the whole of Europe. Paramonov (1962) states that this species sometimes penetrates to healthy plants. Observed by Paesler (1956) in alfalfa roots. It is found chiefly in manure in Poland (Janik 1962), and was also observed in rye (Domurat and Sandner 1960).

It occurred sporadically in alfalfa roots and soil on station *B*. *E*.

Diplogaster s. l. spp. Immature individuals of the genera *Diplogaster* s. l. occurred singly in several plant and soil samples on both stations.

61. *Rhabditis brevispina* (Claus 1862) Bütschli 1873 (Dougherty 1955). A species known from the whole of Europe. Observed in alfalfa crops (plants and soil) by Tulaganov (1949) and Karimova (1957). Found in Poland inter alia in cultivated soils (Witkowska 1958, Witkowski 1958, 1962).

It occurred in the soil on both stations. *E*.

62. *Pelodera strongyloides* (Schneider 1860) Schneider 1866 (Dougherty 1953). Common throughout Europe. Not hitherto reported in alfalfa crops. In Poland found in cow manure (Janik 1962) and in the soil under a barley crop (Witkowski 1962).

It occurred in one of the root samples from station *A*. *E*.

63. *Pelodera teres* Schneider 1866 (Dougherty 1955). A species known from

Europe. Reported several times in Poland, inter alia in cultivated soils (Witkowska 1958, Witkowski 1958). Not hitherto reported from alfalfa crops.

It occurred in manure in Poland (Janik 1962) and cultivated soils (Witkowska 1958, Witkowski 1958).

Two individuals were found in the upper parts of alfalfa plants on station *B*. *E*.

64. *Caenorhabditis dolichura* (Schneider 1866) Dougherty 1955. Known from Europe. A species new to alfalfa crops. In Poland, found in a meadow ditch (Kozłowska 1962) and in horse manure (Janik 1962).

Two individuals found in a sample of the upper parts of alfalfa on station *A*. *E*.

65. *Mesorhabditis spiculigera* (Steiner 1936) Dougherty 1953. A species known from Europe and North America. Not hitherto reported from alfalfa crops. In Poland it was found in natural manure (Janik 1962) and cultivated soil (Witkowska 1958, Witkowski 1958, 1962).

It occurred in several soil samples on station *A* and in root and soil samples on station *B*. Two males were also found in weed roots on station *A*, *Glechoma hederacea* L. *E*.

Rhabditis s.l. spp. Chiefly immature individuals of *Rhabditis* s.l. spp. occurred in soil and plants on both stations, and also in the following weeds from station *A*: *Glechoma hederacea* L., *Achillea millefolium* L. and *Rorippa silvestris* (L.) Bess. *E*.

66. *Panagrolaimus rigidus* (Schneider 1866) Thorne 1937. Species of the genus *Panagrolaimus*, *Cephalobus*, *Eucephalobus*, *Acrobeloides*, *Chiloplacus*, *Cervidellus* and *Acrobeles* are considered as saprobionts. Their occurrence is not connected however with decomposing organic substance only. They have a tendency (in some species very strongly marked) of penetrating into, settling and reproducing in plants, which do not exhibit pathological changes afterwards. Bearing in mind this last property Paramonov (1952) allotted them to a separate ecological group, that is, hemisaprobionts.

P. rigidus is one of the commonest species of the group discussed above, known from Europe and America. It occurs in soil and decomposing organic substance. Paramonov (1962) refers to extensive literature on the abundant occurrence of this species in healthy plant tissues also. It was found by Paesler (1956) in roots and by Deubert (1958) in soil of alfalfa crops. In Poland it was found inter alia in cultivated soils (Witkowska 1958, Witkowski 1958, 1962), park soil (Brzeski 1963c), in mosses (Brzeski 1961) and in manure (Janik 1962).

It occurred in considerable numbers in almost all the soil and plant samples from both stations, and in addition in the following weeds on station *A*: *Avena sativa* L., *Taraxacum officinale* Web., *Achillea millefolium* L., *Glechoma hedera-*

cea L. and *Rorippa silvestris* (L.) Bess. and on station *B*: *Chenopodium album* L., *Melandrium noctiflorum* (L.) Fr., *Erigeron canadensis* L., *Polygonum aviculare* L., *Artemisia vulgaris* L., *Apera spica-venti* (L.) P.B., *Polygonum convolvulus* L., *Bromus mollis* L., *Stellaria media* Vill. and *Achillea millefolium* L. *H.*

67. *Panagrolaimus subelongatus* (Cobb 1914) Thorne 1937. Known from Europe and the United States of America. In the latter it occurs frequently in alfalfa, accompanying the species *Ditylenchus dipsaci.* Found in Poland in park soil (Brzeski 1963c) and in soil under potatoes, spring and winter wheat (Witkowska 1958, Witkowski 1958).

Single individuals occurred in several plant samples from both stations. *H.*

68. *Panagrolaimus* sp. 1. Three individuals belonging to an underscribed species were found in soil on station *A* and in the roots of a weed on this station, *Glechoma hederacea* L. They were distinguished from among the known species of the genus *Panagrolaimus* by their long tail. *H.*

69. *Cephalobus mucronatus* Kozłowska, Roguska-Wasilewska 1963. This species was described on the basis of numerous individuals found in plants and soil of the alfalfa crops examined. This species settled in the greatest numbers in roots in which it occurred in almost all samples. In addition it was observed in weeds on station *A*: *Taraxacum officinale* Web., *Avena sativa* L., *Achillea millefolium* L. and from station *B*: *Polygonum convolvulus* L., *Bromus mollis* L., *Achillea millefolium* L. Not found since 1963, but from verbal information it is known that it has been encountered in other places in Poland and also in Hungary and the Soviet Union. A species new to the fauna of alfalfa. *H.*

70. *Cephalobus nanus* de Man 1880. A common species known from Europe and America. Found by Paesler (1956) in alfalfa roots. Reported several times in Poland in mosses (Brzeski 1961, 1962a), cultivated soils (Witkowska 1958, Witkowski 1958, 1962) and rye (Domurat and Sandner 1960).

It occurred in several root and soil samples on station *B*. *H.*

71. *Cephalobus persegnis* Bastian 1865. A cosmopolitan species often encountered in soil, and also in plants. Found by Paesler (1956) in alfalfa roots and in the upper parts and roots of alfalfa by Karimova (1957). Found in Poland in habitats given for *C. nanus.*

It occurred abundantly in plants and soil on both stations, and also in the following weeds on station *A*: *Avena sativa* L. and *Achillea millefolium* L. and on station *B*: *Stellaria media* Vill. and *Achillea millefolium* L. *H.*

72. *Cephalobus* sp. 1. Individuals were found in alfalfa roots on station *A* and plants on station *B* which most probably belonged to a species not as yet discribed. They were distinguished primarily by the shape of the tail, not encountered in any of the species so far described of the genus *Cephalobus.* *H.*

73. *Eucephalobus oxyuroides* (de Man 1876) Steiner 1936. A cosmopolitan species, known from Europe and America, often encountered in soil and decomposing plant residues. Found by Tulaganov (1949), Paesler (1956) and Karimova (1957) in alfalfa crops. In Poland it was observed in park soil (Brzeski 1963c), cultivated soils (Witkowska 1958, Witkowski 1958, 1962) and rye (Domurat and Sandner 1960).

It occurred in alfalfa roots and in soil on station *A* and very frequently in alfalfa plants and soil on station *B*. In addition it occurred in the roots of a weed on station *B*, *Apera spica-venti* (L.) P.B. *H*.

74. *Eucephalobus paracornutus* de Coninck 1943. Known hitherto from Germany and Iceland. New to alfalfa crops and the fauna of Poland.

It occurred several times in root and soil samples from both stations. *H*.

75. *Eucephalobus striatus* (Bastian 1865) Thorne 1937. A cosmopolitan species, occurring in similar biotopes to those in which *C. persegnis* and *E. oxyuroides* occur. Reported by Tulaganov (1949), Paesler (1956), Karimova (1957) and Deubert (1958) in alfalfa crops (in plants and soil). In Poland it was found in biotopes given for *C. nanus* and *C. persegnis*.

It occurred in the soil on station *A* and plants and soil on station *B*., and also in the roots of the following weeds on station *B*: *Apera spica-venti* (L.) P.B. and *Stellaria media* Vill. *H*.

76. *Eucephalobus* sp. 1. A female and larvae belonging to a species not so far described were found in roots and soil on station *B*. The individuals found differ from the known species of this genus in respect of shape of head. The outline of the body, particularly the tail, is most similar to *E. filiformis* (de Man 1880) Sch., Stek. 1951, but differed by reason the far greater breadth of body. *H*.

77. *Acrobeloides bütschlii* (de Man 1884) Steiner, Buhrer 1933. A common species known from Europe, North America and Venezuela, frequently encountered in soil and in plant tissues. Reported in alfalfa crops by Kirjanova (1935) in plant roots, by Karimova (1957) in plants and soil and by Deubert (1958) in soil. Its occurrence in Poland is analogical to that of *Eucephalobus striatus*.

It occurred numerously in roots and less numerously in the upper parts of alfalfa and in the soil on both stations. It was also found in the roots of *Glechoma hederacea* L. and *Rorippa silvestris* (L.) Bess. – weeds on station *A* and in the roots of *Apera spica-venti* (L.) P.B. and *Polygonum convolvulus* L. – weeds on station *B*. *H*.

78. *Acrobeloides emarginatus* (de Man 1880) Thorne 1937. A common species in Europe. Frequently encountered in soil, and by Russian research workers in plant tissues also. Reported by Karimova (1957) from alfalfa crops (roots, stems and leaves). Found in Poland in the soils under potatoes, red clover (Witkowska 1958) and spring and winter wheat (Witkowski 1958).

It occurred in plants and soil on both stations. *H.*

79. *Acrobeloides minor* (Thorne 1925) Thorne 1937. Hitherto known only from the United States of America. New to alfalfa crops and the fauna of Europe.

It occurred in several root and soil samples on station *B*. *H.*

80. *Acrobeloides setosus* Brzeski 1962. Found by Brzeski (1962c) in soil from glass houses in several places in Poland. New to alfalfa crops.

It occurred chiefly in the soil on both stations. *H.*

81. *Acrobeloides* sp. 1. One female and immature individuals belonging to a species hitherto undescribed were found in alfalfa roots and soil on station *A* and in alfalfa roots on station *B*. The individuals found had fairly large and rounded labial probolae, and cephalic probolae smaller than the above mentioned, but also well formed. The tail was rounded, lateral field composed of 5 lines. Dimensions of 1 female: length 0.57 mm, a–24; b–3.7; c–15; V–59. *H.*

82. *Acrobeloides* sp. 2. Chiefly immature individuals belonging to a species hitherto undescribed were found in plants and soil on station *A* and in roots and soil on station *B*. The individuals found had pointed labial probolae and a tail characteristically drawn upwards. *H.*

83. *Chiloplacus bisexualis* (Micoletzky 1916) Thorne 1937. Known from Europe. Populations of this species do not occur in abundant numbers. Not so far reported in alfalfa crops and in Poland.

It occurred in root and soil samples on station *A* and sporadically in plants and soil on station *B*. *H.*

84. *Chiloplacus quadricarinatus* (Thorne 1925) Thorne 1937. Until recently known only from the United States of America where females of this species were found, inter alia, in alfalfa crop. Recently females and males of this species were found in the soil round the roots and in the roots themselves of *Citrus* sp. in Venezuela (Loof 1964). New to the fauna of Europe.

Representatives of both sexes were found in alfalfa plants and soil on station *A* and in the roots of weeds on this station – *Avena sativa* L. and *Glechoma hederacea* L. *H.*

85. *Chiloplacus soosi* (Andrássy 1953) Andrássy 1959. Found by the author of the species in Hungary and not reported later on. New to alfalfa crops and the fauna of Poland.

It occurred in alfalfa plants (chiefly roots) on station *A* and in plants and soil on station *B*. *H.*

86. *Chiloplacus symmetricus* (Thorne 1925) Thorne 1937. A species known in both hemispheres of the world. It occurs in cultivated soils, wasteland and often in plants (after Paramonov 1964). It has not hitherto been found in alfalfa crops. Found in Poland in moss (Brzeski 1962a) and park soil (Brzeski 1963c).

It occurred abundantly in the majority of the plant and soil samples from both stations, and in addition in the following weeds from station *A*: *Avena*

sativa L., *Taraxacum officinale* Web., *Achillea millefolium* L., *Glechoma hederacea* L. and *Roripp a silvestris* (L.) Bess. and in weeds from station *B*: *Apera spica-venti* (L.) P.B. and *Achillea millefolium* L. *H.*

87. *Cervidellus serratus* (Thorne 1925) Thorne 1937. Hitherto known only from the United States of America. New to alfalfa crops and the fauna of Europe.

It occurred in soil on station *A* and in plants and soil on station *B*. *H.*

88. *Cervidellus vexilliger* (De Man 1880) Thorne 1937. Known from Europe, it is a species which does not form numerous populations. Not hitherto reported in alfalfa crops. Found by Witkowski (1958) in Poland in soil under a potato crop.

It occurred in two soil samples from station *A* and several plant and soil samples from station *B*, and also in the roots of *Apera spica-venti* (L.) P.B. *H.*

89. *Acrobeles ciliatus* Linstow 1877. A common species known from Europe, America and Africa. Reported in alfalfa crops by Tulaganov (1950) in roots, by Karimova (1957) in roots and soil and by Deubert (1958) in soil. Also found several times in Poland: in park soil (Brzeski 1963c), cultivated soils (Witkowska 1958, Witkowski 1958, 1962), rye (Domurat and Sandner 1960) and manure (Janik 1962).

It occurred in roots and soil on station *A* and fairly frequently in plants and soil on station *B*, and in addition in the roots of a weed from station *B*, *Apera spica-venti* (L.) P.B. *H.*

90. *Plectus cirratus* Bastian 1865. Species of the genus *Plectus* are encountered in fresh-water, soils and plants. The source of their food has not as yet been thoroughly investigated, but they probable feed on bacteria or decomposing plant tissue. The fact of the numerous occurrence of certain species of this genus in the upper parts and roots of plants (after Paramonov 1964) indicates that these nematodes are connected with plants. Paramonov allocates them to the same ecological group as representatives of the *Cephalobidae* family, that is, hemisaprobionts.

P. cirratus is a species widespread over the world. It was reported from alfalfa crops by Paesler (1956) and Deubert (1958). In Poland it has often been found in such habitats as bodies of water (including lakes), manure, mosses and soil. It was found in cultivated soils by Witkowska (1958) and Witkowski (1958).

It occurred in plants and soil on both stations and in the upper parts of *Avena sativa* L., a weed on station *A*. *H.*

91. *Plectus geophilus* de Man 1880. A common species in Europe. Not so far reported from alfalfa crops. In Poland it was found inter alia in soil under potatoes and red clover (Witkowska 1958).

Single individuals were observed in plant and soil samples on both stations. *H.*

92. *Plectus granulosus* Bastian 1865. Widespread and most often encountered of all species of the genus *Plectus*. A species particularly closely connected with the rhizospere and root system of plants. Reported from different biotopes (forest, meadow, cultivated fields and wasteland), different types of soil (humus, sandy) and organs of plants with tissues in different stages of decomposition. It was found by Paesler (1956) and by Deubert (1958) in soil under alfalfa crops. In Poland it has been found several times as from 1915, in rivers, lakes, small ponds and soils. It was found by Witkowska (1958) and Witkowski (1958, 1962) in cultivated soils and in rye by Domurat and Sandner (1960).

It occurred frequently and numerously in plants and soil on both stations. It was also found in the roots of the weed *Achillea millefolium* L. on station *A* and in those of *Apera spica-venti* (L.) P.B. and *Achillea millefolium* L. on station *B*. *H*.

93. *Plectus longicaudatus* Bütschli 1873. A common species in Europe. New to alfalfa crops. Reported several times in Poland from such habitats as small bodies of water, mosses and soil.

It occurred in several root and soil samples on station *A*. *H*.

94. *Plectus parietinus* Bastian 1865. A cominon species in Europe. Found in the upper parts and roots of alfalfa by Tulaganov (1949). Mention has been made of the occurrence of this species in Poland in, inter alia, park soil (Brzeski 1963c) and rye (Domurat and Sandner 1960).

It occurred in one of the samples of the upper parts of alfalfa from station *A*. *H*.

95. *Plectus parvus* Bastian 1865. Common in Europe. Not hitherto reported in alfalfa crops. In Poland mention has been made of its occurrence in park soil (Brzeski 1963c) and soil under a winter rape crop (Witkowska 1958).

It occurred in several plant and soil samples from station *A* and root and soil samples from station *B*. It was also found in the upper parts of the weed *Glechoma hederacea* L. on station *A*. *H*.

96. *Wilsonema otophorum* (de Man 1880) Cobb 1913. A common species in Europe. It occurs in soil, often near the roots of plants. Feeding habits unknown. Reported by Belaeva (1951) from alfalfa roots. In Poland it was found in mosses (Brzeski 1961) and park soil (Brzeski 1963c).

It was a rare species in alfalfa roots and soil on the two stations. *P*?

97. *Cylindrolaimus communis* de Man 1880. Known from Europe, Japan and the United States of America, probably cosmopolitan. Considered as a fresh-water or soil form. Feeding habits unknown. Not hitherto reported from alfalfa crops. In Poland it was found inter alia, in park soil (Brzeski 1963c).

It occurred in one of the root samples and three of the soil samples from station *B*. *P*.

98. *Aulolaimus oxycephalus* de Man 1880. A soil species reported from Holland,

Italy, Esthonia and Brazil. Recently (Andrássy 1963) it was found in Hungary in the rhizosphere of *Lupinus polyphyllus* Lindl. Feeding habits unknown. New to alfalfa crops and the fauna of Poland.

One individual was found in the soil on station *A*. *P*.

99. *Monhystera* sp. A total of six individuals, probably belonging to one species, were found in the soil on station *A* and in plants and soil from station *B*. Species of this genus occur in salt and fresh water and in soil. *P*.

100. *Prismatolaimus dolichurus* de Man 1880. A species found in Europe in water or wet soil. The feeding habits of species of the genus *Prismatolaimus* are unknown. Karimova (1957) found them in soil under alfalfa. In Poland they were found several times in the following habitats: different bodies of water, mosses, natural manure and soil. They were found in cultivated soils by Witkowska (1958) and Witkowski (1962).

Single individuals were observed in plants and soil on both stations. *P*?

101. *Prismatolaimus intermedius* (Bütschli 1873) de Man 1880. A common species known from Europe and Africa. Not hitherto found in alfalfa crops. Known in Poland for a long time, chiefly from ponds and small bodies of water. Also found by Brzeski (1963c) in park soil.

Single individuals were observed in two soil samples from both stations. *P*?

102. *Mesodorylaimus bastiani* (Bütschli 1873) Andrássy 1959. Species of the *Dorylaimus* s. l. spp. group are phyto-, zoo- and polyphages. They are often encountered in the rhizosphere of plants. Species feeding on the juices of higher plants sometimes penetrate to tissues. Paramonov (1962) considers that a typical habitat of these species is soil, in which they pass through their whole life-cycle. Contact with plants does not cause pathological changes but may however open up the way for other micro-organisms.

M. bastiani is a cosmopolitan species, occurring in water, soil and plant habitats. According to Soviet scientists (after Paramonov 1962) it is often encountered inside the roots of cultivated plants. It must be agreed that of all the species of the *Dorylaimus* s. l. spp. group, *M. bastiani* is distinguished by the greatest tendency to penetrate into plant tissues. In connection with this Deubert (1959) considers that it should be treated as a semiparasite. It was found by Paesler (1956) in alfalfa roots and by Deubert (1958) in soil of alfalfa crop. In Poland it was found in such habitats as lakes, small bodies of water, mosses and soil. It was reported from cultivated soil by Witkowski (1958) and from rye by Domurat and Sandner (1960).

It occurred in plants and soil on both stations and in roots of weeds on station *B*, *Apera spica-venti* (L.) P.B. and *Bromus mollis* L. *P*.

103. *Eudorylaimus acuticauda* (de Man 1880) Andrássy 1959. Common in Europe. Not hitherto found in alfalfa crops. In Poland mention is made of the occurrence of this species in small bodies of water (Kozłowska 1962) and mosses (Brzeski 1962b).

It occurred in one of the samples of the upper parts of alfalfa plants from station *A*. *P*.

104. *Eudorylaimus carteri* (Bastian 1865) Andrássy 1959. A common species in Europe. Many authors, having observed chloroplasts in the alimentary tract of individuals of this species, suggest that they feed on the green parts of plants. Not hitherto found in alfalfa crops. Known to occur in Poland for a long time in different habitats: mineral springs, small bodies of water, mosses, hare droppings, decomposing plant matter and soil. Found by Witkowska (1958) and Witkowski (1958, 1962) in cultivated soils.

It occurred in several soil samples from both stations. *P*.

105. *Eudorylaimus kirjanovae* (Tulaganov 1949) Andrássy 1959. Tulaganov found this species in the soil round alfalfa roots. Not found in Europe apart from the Soviet Union. New to the fauna of Poland.

It occurred in several plant and soil samples from station *B*. *P*.

106. *Eudorylaimus minutus* (Bütschli 1873) Andrássy 1959. A rarely encountered species, known from Europe and Venezuela. Not hitherto found in alfalfa crops or in Poland.

It occurred sporadically in the soil on station *A* and roots on station *B*. *P*.

107. *Eudorylaimus modestus* (Altherr 1952) Andrássy 1959. Known from Switzerland and recently also reported from Hungary (Andrássy 1962c). Not hitherto found in alfalfa crops or in Poland.

Several individuals were found in the soil on station *B*. *P*.

108. *Eudorylaimus monohystera* (de Man 1880) Andrássy 1959. A common species known from Europe and America. Found in alfalfa crops by Tulaganov (1949) in the soil, by Belaeva (1951) in roots and soil, by Karimova (1957) in roots and by Deubert (1958) in the soil. In Poland it has been found in cultivated soils (Witkowska 1958, Witkowski 1958, 1962).

It occurred in plants and soil on both stations. *P*.

109. *Eudorylaimus obtusicaudatus* (Bastian 1865) Andrássy 1959. A species known in both hemispheres of the world. According to Soviet scientists (after Paramonov 1962) it is also encountered in plant tissues. Found in alfalfa crops by Kirjanova (1935) in roots, by Tulaganov (1949) in plants and soil, by Belaeva (1951) in soil, by Paesler (1956) in roots, by Karimova (1957) in roots and soil and by Deubert (1958) in soil. It has several times been reported in Poland from the following habitats: rivers, lakes, salt springs, small bodies of water, mosses and soil. Found in cultivated soils by Witkowska (1958), Witkowski (1958, 1962) and in rye by Domurat and Śandner (1960).

It occurred singly in plants and soil on both stations. *P*.

110. *Eudorylaimus opistodelphus* (Thorne, Swanger 1936) Andrássy 1959. Hitherto known from the United States of America only. New to alfalfa crops and the fauna of Europe.

It occurred in one of the samples of the upper parts of alfalfa plants from station *B. P.*

111. *Eudorylaimus parvus* (de Man 1880) Andrássy 1959. Known from Europe and the United States of America. Found by Karimova (1957) in alfalfa roots and soil of this crop. In Poland found in moss and different types of soil. Reported in cultivated soils by Witkowska (1958) and Witkowski (1958).

It occurred in roots on station *A* and roots and soil on station *B. P.*

112. *Eudorylaimus pratensis* (de Man 1880) Andrássy 1959. Known from Europe and America, probably a cosmopolitan species. Not hitherto found in alfalfa crops, and in Poland hitherto found only in cultivated soils (Witkowska 1958, Witkowski 1958).

It occurred in plants and soil on both stations. *P.*

113. *Eudorylaimus tritici* (Bastian 1865) Andrássy 1959. A common species in Europe. Not hitherto found in alfalfa crops. Known in Poland from different habitats, including cultivated soils (Witkowska 1958, Witkowski 1958, 1962).

A few individuals occurred in plants and soil on both stations. *P.*

114. *Eudorylaimus* sp. 1. One male was found which did not belong to any of the species of the genus *Eudorylaimus* described in this study. *P.*

115. *Labronema paesleri* Paetzold 1955. Species of the genus *Labronema* differ from each other in their feeding habits. Some are predators (in relation to *Oligochaeta* or *Nematoda*), others feed on algae or probably the juices of higher plants. They often occur in the soil round the roots of plants.

L. paesleri has hitherto been found only in Germany. It is a species not hitherto reported from alfalfa crops and in Poland.

Single individuals were observed in several soil and root samples from station *A* and from soil samples on station *B. P.*

116. *Labronema* sp. 1. An immature individual was found in one of the root samples, for which it proved impossible to determine the species to which it belonged. It was only known that it did not belong to the species *L. paesleri. P.*

117. *Pungentus engadinensis* (Altherr 1950) Altherr 1952. Species of the genus *Pungentus* occur round the roots of plants. Their feeding habits are unknown.

P. engadinensis has hitherto been found in Europe (Switzerland, England and Hungary). It was found once in Poland in park soil (Brzeski 1963c). New to alfalfa crops.

Single individuals were observed in several soil samples from station *B. P.*

118. *Pungentus marietami* Altherr 1950. Hitherto known only from Switzerland. Not hitherto reported from alfalfa crops. In Poland it was found in park soil (Brzeski 1963c) and in soil round the roots of grasses (Brzeski 1964).

A few individuals occurred in the soil on both stations. *P.*

119. *Discolaimus texanus* Cobb 1913. Known from Europe and common in the United States of America. Probably predatory, attacking *Oligochaeta* and some of nematodes. It is found among the roots of plants. Not hitherto reported in alfalfa crops and Poland.

Single individuals were found in soil samples from both stations. *P.*

120. *Aporcelaimus superbus* (de Man 1880) T. Goodey 1951. Known from Europe, probably a predatory species. Encountered in the rhizosphere of plants. Not hitherto found in alfalfa crops. In Poland there is mention of the occurrence of this species in soil under spring and winter wheat (Witkowski 1958).

It occurred sporadically in roots and soil on station *A* and in soil on station *B*. *P.*

121. *Prodorylaimus longicaudatus* (Bütschli 1874) Andrássy 1959. A water and soil species, known from Europe and America. Not hitherto found in alfalfa crops. It is encountered in Poland in different habitats: in small bodies of water, salt springs, moss and soil. Found in cultivated soils by Witkowska (1958) and Witkowski (1958, 1962).

It occurred in several soil samples from station *A*. *P.*

122. *Tylencholaimus minimus* de Man 1876. Known from Europe and America. It occurs round plant roots or in mosses and peat mosses. Not so far reported in alfalfa crops. In Poland it was found inter alia in cultivated soils (Witkowska 1958, Witkowski 1958).

It occurred in one of the root samples from station *A*. *P.*

123. *Longidorus elongatus* (de Man 1876) Thorne, Swanger 1936. Known from Europe and America as an ectoparasite of plant roots. Different opinions are expressed in literature as to the degree to which this species is pathogenic. Allocated to the group of nematodes carrying viruses. Not hitherto reported in alfalfa crops. In Poland it was found in park soil (Brzeski 1963c) and cultivated soils (Witkowska 1958, Witkowski 1958, 1962).

It occurred in one of the soil samples from station *B*. *PO.*

124. *Dorylaimellus demani* Goodey 1963. The occurrence of species of the genus *Dorylaimellus* is connected with the rhizosphere of plants, but their feeding habits are as yet unknown.

D. demani has been known hitherto from probably only Europe and the United States of America. It is new to alfalfa crops and the fauna of Poland.

Single individuals were observed is several soil samples on both stations. *P.*

125. *Dorylaimellus parvulus* Thorne 1939. Hitherto known only from the United States of America. Recently Loof (1964) also reported the occurrence of this species in soil and roots of many plants in Venezuela. New to alfalfa crops and the faune of Europe.

It occurred fairly numerously in soil on both stations. *P.*

126. *Nygolaimus amphigonicus* Thorne 1930 (Altherr 1950). Hitherto known

from the United States of America and Europe. Found inter alia round the roots of plants, considered as a predatory species. New to alfalfa crops. Mention has been made of the occurrence in Poland of this species in park soil (Brzeski 1963c).

It occurred in one of the soil samples from each station. *P.*

127. *Nygolaimellus captivitatis* Andrássy 1962. The author of the species (Andrássy 1962b) found it in soil round the roots of grasses in Hungary. Feeding habits unknown. New to alfalfa crops and the fauna of Poland.

It occurred chiefly in soil on the two stations. *P*

128. *Dorylaimoides micoletzky* (de Man 1921) Thorne, Swanger 1936. Known from Europe, the United States of America and Japan. Feeding habits unknown. Not hitherto found in alfalfa crops and in Poland.

It occurred in several soil samples on station *A*. *P*.

129. *Dorylaimoides teres* Thorne, Swanger 1936. Known from Europe and the United States of America, probably cosmopolitan, but a rare species. New to alfalfa crops and the fauna of Poland.

It occurred in several soil samples from station *B*. *P*.

130. *Tylencholaimellus striatus* Thorne 1939. Known from the United States of America and Europe. Also found by Loof (1964) in soil and also in the roots of potatoes, tomatoes and strawberries from Venezuela. Not hitherto reported in alfalfa crops or Poland.

It was observed in several samples, chiefly soil samples, from station *A*. *P*.

131. *Alaimus acutus* Thorne 1939. Species of the genus *Alaimus* are soil forms, encountered in the rhizosphere. Feeding habits unknown.

A. acutus has hitherto been known from the United States of America only. Not so far reported in alfalfa crops or in Europe.

It occurred in two soil samples from station *B*. *P*.

132. *Alaimus parvus* Thorne 1939. Known from America, Europe and Africa. Not hitherto found in alfalfa crops. In Poland it has been found in moss (Brzeski 1962a) and park soil (Brzeski 1963c).

It occurred in one plant samples and one soil sample from station *B*. *P*.

133. *Alaimus primitivus* de Man 1880. A widespread species in Europe and America. Found in alfalfa crops by Tulaganov (1949), Belaeva (1951) and Paesler (1956). It has been found in Poland in many habitats: mountain lakes, salt springs, moss and soil. Reported in cultivated soil by Witkowska (1958) and Witkowski (1958, 1962).

It occurred in soil and in plant roots on both stations. *P*.

134. *Amphidelus* sp. Found in one of the soil samples from station *B*. *P*.

135. *Diphtherophora brevicolle* Thorne 1939. The author described this species on the basis of females found in the soil of an alfalfa crop in the United States of America. This species was also found in park soil in Poland (Brzeski 1963c).

In the crops examined, particularly on station *B*, a male was found, from among several females, and described (Wasilewska 1964a). *P.*

136. *Diphtherophora communis* de Man 1880. A common soil species in Europe, encountered in the rhizosphere of plants. Feeding habits unknown. Found by Belaeva (1951) in the soil of alfalfa crops. In Poland it was found in park soil (Brzeski 1963c) and cultivated soil (Witkowski 1958).

In the crops examined single individuals were observed, chiefly in soil samples. *P.*

137. *Trichodorus* sp. Four immature individuals were found in soil samples from station *A*. Species of the genus *Trichodorus* are ectoparasites of plant roots, and the majority of them are distinguished by pathogenic properties. Species of the genus *Trichodorus* were found in alfalfa crops in America. *OP.*

Among the 137 species presented, 10 species were found for the first time, and 3 of them were described as species new to science. These are: *Cephalobus mucronatus*, *Ditylenchus medicaginis* and *Tylenchus sandneri*. Descriptions of the following 4 species were supplemented by descriptions of males: *Aglenchus costatus*, *Tylenchus magnidens*, *Tylenchus baloghi* and *Diphtherophora brevicolle*. The descriptions form the subject of separate publications.

In the crops examined for the purposes of this study, 53 species new to the fauna of Poland were found to occur, of which 12 species were hitherto unknown in Europe. 78 species were found in alfalfa crops for the first time. These facts prove that the knowledge we have so far of the nematofauna of cultivated plants is scanty.

The number of species of nematodes found in the two crops of alfalfa examined is large in comparison with the results obtained by other research workers, which analysed alfalfa crops. Kirjanova (1935) found 9 species in alfalfa plants (these including 7 of the species which I also found). Tulaganov (1941) who examined only plants from Uzbegistan, found 28 species, and later this same author (1949) found in the same region, in soil and plants, as many as 55 species (only 16 of which were recorded by me). Tulaganov (1950) established the occurrence in plants only of 14 species (5 of which were common to both soil and plants) in alfalfa crops from the other region of Soviet Union. Belaeva (1951) and Karimova (1957) investigated the nematofauna of alfalfa crops in relation to both plants and soil. The first of them found 23 species (11 common ones) and the second 39 (19 common ones). Paesler (1956) in analysing the roots and soil round the roots of alfalfa in Germany found 41 species (which included 17 common ones) while Deubert (1958) found 17 species in the same soil (11 common ones).

V. COMPARISON OF FREQUENCY OF OCCURRENCE OF NEMATODE SPECIES IN THE UPPER PARTS OF ALFALFA PLANTS, IN THEIR ROOTS AND IN SOIL

The alfalfa crops examined were settled by a large number of species. The largest number of species occurred in soil, fewer in roots and fewest in the green organs of plants. A larger number of species was found in the soil under the crop on station *A* than in the soil on station *B*, but the roots, and particularly the upper parts of the plants on station *B* were characterised by a greater variety of species than on station *A* (Tab. VI).

Number of species in plants and soil observed over the whole study period on both stations

Tab. VI

	Station *A*		Station *B*	
	number of species	per cent	number of species	per cent
Plant and soil	112+*D*+*R*	100.0	109+*D*+*R*	100.0
Soil	101+*D*+*R*	88.5	87+*D*+*R*	80.2
Alfalfa roots	67+*D*+*R*	60.5	69+*D*+*R*	63.9
Upper parts of alfalfa plants	37	32.4	56+*D*+*R*	52.3

D = *Diplogaster* s. l., *R* = *Rhabditis* s. l.

In order to determine the preferences of different species in relation to the upper parts of plants, roots and soil, analysis was made of the frequency of occurrence of these species in samples from the above-mentioned habitats, separately for the two stations (Fig. 1, *A* and 1, *B*). Comparisons were made on the basis of two study periods (1960/1961 and 1962/1963 jointly). Data on the frequency of occurrence of species found in soil were placed on the left side, and on the right, data on species found in the upper parts of plants, while data on species occurring in roots were placed in the centre. Endeavour was made to arrange species according to frequency of occurrence decreasing in the soil habitat and increasing in the plant habitat. When arranging species occurring simultaneously in soil, roots and upper parts, allocation was made in accordance with the appropriate sequence first for the upper parts of plants (as being the most uniform habitat), then for roots. Several species, the frequency of occurrence of which was small, were arranged in accordance with the knowledge we have at present of their way of life. On the basis of frequency of occurrence of species in soil, root and green organ the following three groups of species were distinguished in the crops examined:

1. The group of species encountered in the soil only – Fig. 1, *A* No. *1–41*; Fig. 1, *B* No. *1–24*.

2. The group of species encountered in the soil and in alfalfa roots – Fig. 1, *A* No. *42–72*; Fig. 1, *B* No. *25–43*.

3. The group of species encountered in the soil, roots and upper parts of alfalfa plants – Fig. 1, *A* No. *82–100*; Fig. 1, *B* No. *61–103*.

Species not included in the above groups but included in the comparison (Fig. 1, *A* and 1, *B*) either occurred in the upper parts of plants only, or in roots only, or in soil and upper parts of plants, or in the upper parts and roots of plants. Their frequency of occurrence was very slight (they occurred chiefly in the lowest class, that is, from 1–20% of all samples). They therefore formed a group of species occurring fortuitously in one of the habitats examined in the alfalfa crops investigated.

1. The first group, similarly to the remainder, is not uniform from either the systematic or ecological aspect. It consists of a) parasitic species (on station *A*): *Tylenchorhynchus claytoni*, *T. .lenorus*, *T. ornatus*, *T. .macrurus*, *Ditylenchus dipsaci*, *Paratylenchus aciculus*, *P. .microdorus*, *Trichodorus* sp. and (on station *B*): *Tylenchorhynchus ornatus*, *Paratylenchus nanus* and *Longidorus elongatus*, which either under the given conditions did not penetrate into the plants, or at the moment samples were taken were engaged in migration; b) other species (chiefly of the order *Dorylaimida*), the true habitat of which is soil. Apart from two species (*Boleodorus thylactus* and *Dorylaimellus parvulus*) the frequency of occurrence of species in this group is slight. The small percentage of saprobiotic species in this group is also characteristic.

2. The second group includes a) roots parasites (on station *A*): *Pratylenchus neglectus*, *P. penetrans*, *P. pratensis*, *Tylenchorhynchus brevidens*, *T. striatus*, *T. nothus*, *Nothotylenchus acris* and *Laimaphelenchus penardi* (mycophage?) and (on station *B*): *Pratylenchus neglectus*, *Meloidogyne hapla*, *Tylenchorhynchus claytoni* and *T. .lenorus*; b) saprobiotic species, composed on both stations chiefly of representatives of the *Cephalobidae* family, but on station *A* they are joined by species of the genera: *Rhabditis* s. l. and *Diplogaster* s. l ; c) species, the true habitat of which is soil, and of which any connection with plants is transitory and probably does not constitute any danger to the plant (on station *A*): *Eudorylaimus pratensis*, *Tylencholaimellus striatus*, *Labronema paesleri*, *Aporcelaimus superbus* and species of the genera *Tylenchus*, *Prismatolaimus*, *Alaimus* and *Wilsonema* and (on station *B*): *Eudorylaimus parvus*, *Nygolaimellus captivitatis* and species of the genera *Tylenchus* and *Wilsonema*. Apart from *Pratylenchus neglectus* (often encountered in the soil on station *B*) the frequency of occurrence of species in this group is small.

3. The third group contains species with the greatest frequency of occurrence. On station *B* (the older crop) the number of these species is greater. They will be discussed separately for each station. Three species can be

distinguished on station *A*: *Panagrolaimus rigidus*, *Aphelenchoides saprophilus* and *Paraphelenchus pseudoparietinus*, which occur more frequently in the upper parts of plants than in roots and soil. The saprobiotic species *P. rigidus* exhibits a strong tendency to concentrate in plant tissue. This fact was observed by other authors also (Balbaeva 1961, 1962–1963, Bologova 1962). The significance of this species to plants is not as yet fully known. The two remaining species may be considered as facultative parasites. The next group of species predominates in roots, but occurs with equal frequency in soil as it does in the upper parts of plants. These are primarily saprobionts (*Chiloplacus symmetricus*, *Cephalobus mucronatus*, *Plectus granulosus*, *P. cirratus*, *Cephalobus persegnis*, *Acrobeloides bütschlii*, *A. emarginatus* and *Chiloplacus quadricarinatus*), then parasites (*Helicotylenchus canadensis*, *Ditylenchus medicaginis*, *Aphelenchus avenae*, *Aphelenchoides bicaudatus* (parasite-mycophage?), also species of the *Dorylaimidae* family (*Mesodorylaimus bastiani*, *Eudorylaimus kirjanovae*) and species of the genus *Tylenchus* (*T. vulgaris* and *T. thornei*) and *Aglenchus costatus*. The remaining species contained between No. *82* and *90*, in principle predominate in soil. One of them (*Tylenchorhynchus dubius*), as a typical ectoparasite, is of great significance to plants.

On station *B* the following four species are included in the group of species more often encountered in the upper parts of plants: *Panagrolaimus rigidus* and *Aphelenchoides saprophilus*, with considerable frequency of occurrence, and *Paraphelenchus pseudoparietinus* and *Deladenus durus*, with low frequency of occurrence. The next group is formed by frequently occurring species primarily in roots, but with frequency of occurrence in the upper parts of plants greater than that in soil. These are *Ditylenchus medicaginis* and *Plectus granulosus*. In turn it is possible to distinguish a group of species most frequent in roots, and almost as frequent in soil. These are the saprobiotic species: *Cephalobus mucronatus*, *C. persegnis*, *Chiloplacus symmetricus* and the typical parasite of roots *Tylenchorhynchus dubius*. Among species most frequent in soil and far less frequent in plants we must include the three saprobionts (*Rhabditis* s. l. spp., *Acrobeles ciliatus*, *Eucephalobus oxyuroides*), *Mesodorylaimus bastiani* (a soil species, but also often found in plants), and two facultative parasites (*Aphelenchus avenae* and *Ditylenchus intermedius*) Species coming between No. *75* and *87* are frequent in roots, or soil and roots, but are encountered only sporadically in the upper parts of plants. These are saprobionts (*Acrobeloides bütschlii*, *A. emarginatus*, *Acrobeloides* sp. 2, *Chiloplacus soosi*, *Cephalobus* sp. 1, *Cervidellus serratus*), the parasites (*Tylenchorhynchus brevidens* and *Helicotylenchus canadensis*) and species considered as soil species, but also found in plants (*Eudorylaimus obtusicaudatus*, *E. tritici*) and *Tylenchus vulgaris*. The last group of species, coming

between No. *61* and *74*, is characterised by the smallest degree of frequency of occurrence and includes species of all the ecological groups of nematodes.

To sum up it must be stated that the majority of the species occurring in the soil of the alfalfa crops examined penetrated into plants. Only a small number of these species, however, maintained constant contact with plants.

The ratio of number of species of the order *Tylenchida* to the number of remaining species (expressed in percent) was similar in the upper parts of plants, roots and soil, or higher in plants in comparison with soil. The analogical ratio of number of saprobiotic species to the number of remaining species was lower in soil in comparison with roots and upper parts of plants. The situation with the group of "other" species (mainly of the order *Dorylaimida*), was the reverse of that of the saprobionts, the analogical ratio of number of species being lower in roots and upper parts of plants in comparison with soil (Tab. VII). It was therefore mainly species of the order *Tylenchida* and saprobiotic species which penetrated into plants.

Comparison of number of species (expressed in per cent) of the order *Tylenchida*, from the group of saprobionts and other nematodes in the three habitats examined in the alfalfa crops (all the species in a given habitat taken as 100%)

Tab. VII

	Soil			Roots			Upper parts		
	Tylenchida	saprobionts	others	*Tylenchida*	saprobionts	others	*Tylenchida*	saprobionts	others
Station *A*	46	25	29	49	33	18	46	38	16
Station *B*	37	29	34	45	40	15	49	35	16

The most frequently encountered species in the younger crop on station *A* was *Helicotylenchus canadensis*, *Aphelenchoides saprophilus*, *Panagrolaimus rigidus*, *Chiloplacus symmetricus* and *Cephalobus mucronatus*. More parasitic and saprobiotic species with considerable frequency of occurrence were found in the older alfalfa crop on station *B*. These were: *Ditylenchus medicaginis*, *Tylenchorhynchus dubius*, *T. brevidens*, *Pratylenchus neglectus*, *Aphelenchoides saprophilus*, *Aphelenchus avenae* and *Panagrolaimus rigidus*, *Plectus granulosus*, *Cephalobus mucronatus*, *C. persegnis*, *Chiloplacus symmetricus* and *Acrobeloides bütschlii*.

VI. SUMMARY OF RESULTS

Investigations made over a period of two years of alfalfa crops of different ages showed that:

1. The crops examined are characterized by considerable variety of species and of ecological forms of nematodes settling in both the upper parts and roots of alfalfa plants and in the soil.

2. The greatest number of species occurred in the soil, fewer in roots and fewest in upper parts of the plants.

3. A large number of species with low frequency of occurrence (rare) were found in the two crops and relatively few species with high frequency of occurrence (frequent).

4. The majority of the species occurring in the soil penetrated into the plants. Only a small number of the species which penetrated into the plants, however, maintained constant contact with them. It was chiefly species of the order *Tylenchida* and saprobiotic species which penetrated into plants.

5. In the group of species penetrating into plants more parasitic and saprobiotic species with high frequency of occurrence were found in the older alfalfa crop in comparison with the younger alfalfa crop.

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ANALIZA ZASIEDLANIA NICIENI W UPRAWACH LUCERNY. I. SKŁAD GATUNKOWY NICIENI DWÓCH RÓŻNOWIEKOWYCH UPRAW LUCERNY ORAZ PENETRACJA GATUNKÓW Z GLEBY DO ROŚLIN

Streszczenie

Ze względu na brak jakichkolwiek opracowań nicieni występujących w uprawach lucerny w Polsce podjęto zadanie analizy jakościowego i ilościowego składu nicieni w roślinach i glebie tych upraw.

Celem pierwszej pracy na ten temat było: 1) ustalenie pełnego składu gatunkowego nicieni zasiedlających dwie uprawy: młodszą i starszą, co pozwoliło równocześnie na rozeznanie w różnorodności form ekologicznych tych nicieni i 2) porównanie nasilenia występowania gatunków w częściach nadziemnych lucerny, korzeniach i glebie, co jest równoznaczne z oceną penetracji poszczególnych gatunków z gleby do roślin.

Badania przeprowadzono na dwóch polach lucerny położonych w okolicach Warszawy. W momencie rozpoczęcia badań na jednym z pól była lucerna jednoroczna, na drugim – trzyletnia. Badania przeprowadzano od lipca 1960 roku do lipca 1961 roku i od maja 1962 roku do maja 1963 roku. Próby z części nadziemnych roślin, korzeni i gleby pobierano raz w miesiącu. Za próbę polową uznano 10 roślin i 10 lasek glebowych pobranych losowo. Analizę gatunkową przeprowadzano na podstawie prób o wielkości 5 g części

nadziemnych roślin, 5 g korzeni i 20 ml gleby, a więc prób wydzielonych z prób polowych. Ekstrakcję nicieni przeprowadzano za pomocą zmodyfikowanej metody Baermana (tab. I, II, III, IV i V). Próby przeznaczone do analiz gatunkowych liczyły w sumie 17 745 osobników nicieni. Trwałe preparaty tych nicieni znajdują się w Instytucie Ekologii PAN.

W badanych uprawach stwierdzono występowanie 137 gatunków nicieni, należących do 54 rodzajów z 22 rodzin. Kilka gatunków było nowych, z których 3 już opisano w oddzielnych publikacjach. Są to: *Cephalobus mucronatus*, *Ditylenchus medicaginis* i *Tylenchus sandneri*. Opisy 4 następujących gatunków uzupełniono opisami samców: *Aglenchus costatus*, *Tylenchus magnidens*, *T. baloghi* i *Diphtherophora brevicolle*. Wśród znalezionych gatunków 53 było nowych dla fauny Polski, z tego 12 dotychczas nieznanych w Europie. 78 gatunków stwierdzono po raz pierwszy w uprawach lucerny.

Na podstawie dwuletnich badań dwóch różnowiekowych upraw lucerny stwierdzono:

1. Badane uprawy charakteryzowały się dużym bogactwem gatunkowym oraz dużą różnorodnością form ekologicznych nicieni zasiedlających zarówno części nadziemne lucerny, korzenie jak i glebę (fig. 1).

2. Najwięcej gatunków występowało w glebie, mniej w korzeniach i najmniej w częściach nadziemnych roślin (tab. VI).

3. W obydwu uprawach stwierdzono dużo gatunków o małej częstości występowania (rzadkich) oraz stosunkowo mało gatunków o dużej częstości występowania (częstych) (fig. 1).

4. Większość gatunków występujących w glebie penetrowała do roślin. Jednak tylko niewielka ilość gatunków penetrujących do roślin utrzymywała z nimi trwały kontakt. Do roślin penetrowały głównie gatunki z rzędu *Tylenchida* oraz gatunki saprobiotyczne (fig. 1 i tab. VII).

5. W grupie gatunków penetrujących do roślin stwierdzono więcej pasożytniczych i saprobiotycznych gatunków o dużej częstości występowania w uprawie lucerny starszej w porównaniu z uprawą lucerny młodszej (fig. 1).

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